RADIATION STERILIZATION OF FOODS

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MAIN
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HEARING

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SUBCOMMITTEE ON
RESEARCH AND DEVELOPMENT

OF THE

JOINT COMMITTEE ON ATOMIC ENERGY
CONGRESS OF THE UNITED STATES

EIGHTY-FOURTH CONGRESS

FIRST SESSION

ON

RADIATION STERILIZATION OF FOODS

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BIOGRAPHICAL SKETCHES OF WITNESSES

Maj. Gen. Kenner Fisher Hertford

Kenner Fisher Hertford was born in Galveston, Tex., September 25, 1900. He graduated from high school in Houston and entered the United States Military Academy, from which he was graduated June 12, 1923, and commissioned a second lieutenant in the Corps of Engineers.

In September 1923 he entered the Engineer School at Fort Humphreys, Va., graduated in January 1924, and joined the 2d Engineers at Fort Sam Houston, Tex. In July 1925 he entered Cornell University, from which he received a civil engineering degree a year later. He then became an instructor of engineer units of the South Carolina National Guard.

General Hertford was transferred to the 11th Engineers at Corozal, Panama Canal Zone, in December 1930, where he remained until August 1932, when he became a mathematics instructor at the United States Military Academy. He was named assistant to the district engineer at Jacksonville, Fla., in July 1936.

In April 1938 General Hertford was transferred to Paris, France, as administrative officer of the American Battle Monuments Commission. From October 1940 to January 1941, he served as a military observer in the United Kingdom and then was assigned to the Operations and Training Branch of the Office of the Chief of Engineers at Washington, D. C. He became a member of the Latin American Section, Theater Group, Operations Division, of the War Department General Staff in March 1942 and in July 1943 was named Chief of that Section.

In May 1944 General Hertford was appointed deputy commander of the United States Army Forces in the South Atlantic, with station at Recife, Brazil. He was reassigned to the Operations Division, War Department General Staff, in January 1945, as Chief of the Pan American Group. In May 1946 he entered the National War College, graduated in June 1947, and became Army assistant on the Military Staff Committee to the United Nations at New York City.

General Hertford was named deputy commander of Sandia Base, Albuquerque, N. Mex., in March 1948. In September 1950 he became chief of staff of the Special Weapons Command at Sandia Base; in February 1952 was appointed research and development coordinator of that command and in July 1952 resumed his former position as chief of staff.

In November 1952 General Hertford was assigned to Army headquarters as Assistant Chief of the Research and Development Division, Office of the Assistant Chief of Staff for Logistics, and the following March became Assistant Deputy for Research and Development to the Assistant Chief of Staff for Logistics.

General Hertford was named Deputy Assistant Chief of Staff, G–4, for Research and Development in October 1953.

In September 1954 General Hertford was named Director of Research and Development, Office of Deputy Chief of Staff for Logistics.

In December 1954 General Hertford was named Chief of Research and Development Office, Chief of Staff, Department of the Army.

General Hertford has been awarded the Distinguished Service Medal and Legion of Merit.

Col. William D. Jackson

Col. William D. Jackson received his bachelor of science degree in industrial management at the University of Southern California. He was commissioned in the Infantry Reserve in 1925 and entered on active duty July 10, 1941, as a first lieutenant. He attended Command and General Staff School 1942–43. He was awarded the Army Commendation Ribbon by Headquarters, 9th Service Command in 1945; Legion of Merit by Army Forces, Western Pacific in 1946. He attended Quartermaster Subsistence School in Chicago in 1947 and then became commandant of that school. After a tour in OQMG, he was transferred to the Far East Command in November 1949. At the beginning of the Korean operation, he was in charge of subsistence logistics and later deputy quartermaster of Japan Logistical Command and received an Oak Leaf Cluster to the Legion of Merit for this work. He is now Chief of Research and Development Division of OQMG which exercises staff supervision over the total Quartermaster research and development, including the radiation sterilization of foods.

Capt. Reuben Pomerantz

Capt. Reuben Pomerantz, born August 10, 1921, at Hartford, Conn., graduated from the Weaver High School at Hartford in 1939 and from Trinity College, Hartford, in 1943, with a bachelor of science in chemistry. Having entered the Army Air Force in 1942, he later received an honorable discharge in order to enter the United States Military Academy in 1943. He graduated in 1946, standing high in his class and showing promise of an outstanding military career in the future.

After graduation, Captain Pomerantz attended the branch immaterial course at Fort Benning and was then assigned to Fort Lee, Va., where he attended the following courses: Basic officers' course, officer mess management, and advanced food service school. In 1948 he left Fort Lee to serve in the Canal Zone as assistant commandant of the Food Service School, food service supervisor, Quartermaster purchasing and contracting officer, and Chief, Stock Control Division. Upon completion of his overseas tour in 1951, Captain Pomerantz attended the Massachusetts Institute of Technology from where he obtained the master of science degree in food technology in 1952 on a thesis entitled "Potential Applications of the Rapid Scanning of Spectrophotometer for the Objective Evaluation of Food Color." Captain Pomerantz after graduation was assigned to the Quartermaster Food and Container Institute, first in the Military Operations

Office and in the autumn of 1953 as radiation sterilization officer in the recently initiated radiation sterilization project. In his present capacity "he plans, coordinates, and directs research and development with the overall objective of preserving food products by radiation sterilization" under the general supervision of Dr. Bruce H. Morgan, chief of the project. Captain Pomerantz has presented several technical papers at scientific meetings and authored journal articles. He is a member of various technical societies and honorary fraternities.

Charles R. Horner

Mr. Horner's primary interest is in fission product utilization and development of reactor shielding information and data.

In 1943 he received a bachelor of arts degree in physics at Catawba College, Salisbury, N. C., and was employed by the National Bureau of Standards Ordnance Division, 1943–44. He served as a lieutenant in the United States Navy from 1944 to 1946. After World War II, he returned to the National Bureau of Standards where he conducted research in the fields of physical electronics and nuclear radiation and performed graduate work in physics at the University of Maryland and the National Bureau of Standards Graduate School, 1946–50. During the period 1950–52 he was employed at the United States Navy Bureau of Ships, Electronics Division, as a physicist. He has been with the United States Atomic Energy Commission since 1952.

Dr. Herman Fink Kraybill

Born at Marietta, Pa., June 27, 1914; married 1941, children, 3.

Education: Franklin and Marshall College, bachelor of science, 1936; University of Maryland, master of science, 1938; University of Maryland, doctor of philosophy (biochemistry), 1941.

Positions held: Instructor, chemistry, Maryland, 1936–37; fellow and scientific aide, Fish and Wildlife Service, United States Department of the Interior, technological laboratory, 1938–41; research chemist, research laboratory, Swift & Co., 1941–43; Sanitation Corps, United States Army, 1943–46; research biochemist, Moorman Manufacturing Co., Illinois, 1946; National Dairy Research Laboratories, Baltimore, 1946–48; research associate, National Research Council, Washington, D. C., 1948–49; research biochemist, Bureau of Animal Industry, United States Department of Agriculture, 1949–53; supervisory biochemist and Chief, Chemistry Division, Army Medical Nutrition Laboratory, 1953–

Professional societies: American Chemical Society, American Society for Atomic Education, American Association for the Advancement of Science, Sigma Xi, Alpha Chi Sigma.

Fields of experience: Food research; fats and oils; animal and human nutrition; animal feeds; protein and enzyme research; dairy products; meats; body composition research; research in allergy (foods); chemical and biological coordination work; nutritional and toxicological studies of irradiated foods.

Ralph G. H. Siu

Born February 24, 1917, in Honolulu, T. H. Bachelor of science in chemistry in 1939 and master of science in plant physiology in 1941 from the University of Hawaii and doctor of philosophy in bioorganic chemistry from California Institute of Technology in 1943.

Served in the following capacities: Research fellow at the Pineapple Growers experiment station in Hawaii 1939–41; teaching fellow at California Institute of Technology, 1941–43; assistant chemist in United States Department of Agriculture emergency rubber project 1944; research associate in Harvard University, 1949–51.

Engaged in research with the United States Army Quartermaster Corps since 1945, moving successively from biochemical bench investigator, group leader, director of pioneering research, to the current position of Technical Director.

Maj. Gen. Kester Lovejoy Hastings

Kester Lovejoy Hastings was born in Lewiston, Idaho, March 20, 1897. He was graduated from the United States Military Academy November 1, 1918, appointed a second lieutenant of Infantry, and assigned to the Infantry Machinegun Center at Camp Hancock, Ga.

Soon thereafter he joined the 3d Division in Germany and in 1919 was settling claims arising out of the First World War in Paris. In 1920 he became a senior instructor for the first West Point Preparatory School at Camp Grant, Ill., and later was on duty at Fort Wayne, Mich., as adjutant.

In 1925 General Hastings entered the Signal School, from which he graduated in 1926, and joined the 4th Infantry at Fort Wright, Spokane, Wash. In 1929 he was transferred to the 27th Infantry where he commanded the machinegun company until he became adjutant at Kilauea Military Camp, T. H. He later was assistant provost marshal for the Hawaiian Department. In 1931 he entered the Quartermaster School at Philadelphia, graduated in 1932, and was assigned at the Army Medical Center in Washington, D. C. He was transferred to the Quartermaster Corps August 15, 1934.

General Hastings was graduated from the Army Industrial College in 1936 and from the Command and General Staff School in 1937. He then was assigned to Fort Douglas, Utah, and the Ogden Ordnance Depot on construction work in that area. In the fall of 1940 he joined the Construction Division, Office of the Quartermaster General, where he was in charge of the operational construction of camps in the United States.

In October 1941 General Hastings was appointed assistant to the quartermaster at the Army War College and in March 1942 became executive officer of the Personnel Division in the Office of the Quartermaster General. In January 1944 he was named deputy director of the Military Personnel Branch of the Personnel Division there; in September 1945 became Director of the Personnel Division and in January 1947 was designated Chief of the Personnel and Training Division in that Office. During 1948 he was placed in charge of the Memorial Division.

General Hastings became quartermaster of the Far East Command, with station at Tokyo, Japan, in May 1949.

On September 1, 1952, he was appointed Acting the Deputy Quartermaster General at Army Headquarters, Washington, D. C.

On August 28, 1953, he was appointed Acting the Quartermaster General.

On January 25, 1954, President Eisenhower nominated him to be the Quartermaster General. The Senate confirmed his nomination on February 5, 1954, and he was sworn in as the Quartermaster General on the same date.

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RADIATION STERILIZATION OF FOODS

MONDAY, MAY 9, 1955

CONGRESS OF THE UNITED STATES,
SUBCOMMITTEE ON RESEARCH AND DEVELOPMENT OF THE
JOINT COMMITTEE ON ATOMIC ENERGY,
Washington, D. C.

The Subcommittee on Research and Development of the Joint Committee met at 10:30 a. m., pursuant to notice, in room 318, House Office Building, Representative Melvin Price (chairman of the subcommittee) presiding.

Present: Representatives Price, Van Zandt, and Hinshaw.

Present also: Edward L. Heller, staff member for research.

Representative PRICE. The meeting will be in order.

The Joint Committee on Atomic Energy has been interested in the possibility of radiation sterilization of food for several years. I can personally recall discussing the subject with scientists at the Brookhaven National Laboratory several years ago. At that time, however, the project was a little more than a gleam in the scientists' eyes.

Last year during the Research and Development Subcommittee hearing on the contribution of atomic energy to agriculture,[1] Dr. Butts of the Atomic Energy Commission discussed the possibilities of food sterilization through the use of ionizing radiation.

The committee was happy to learn at that time that the program had advanced in the laboratory to the point where there were real possibilities of practical application. Soon after this hearing, we were pleased to learn that the Department of Defense felt that the project had sufficient possibilities to warrant a major research and development effort.

The Department of Defense now has underway under the direction of the Army Quartermaster Corps and in cooperation with the Atomic Energy Commission a $5 million research and development effort, which I understand is designed to reach the pilot stage in 1958. The purpose of this hearing today is to give the committee, the Congress, and the people an up-to-date picture of the status of this very important program.

The subcommittee will also be interested in learning of the problems yet to be solved in this area, and of the witness' estimates of the potentialities of this new industry in the years to come. I think we should all keep in mind that this new industry wherein food will be sterilized through ionizing radiation gives promise of being one of the really early applications of the peaceful atom on a large scale; raising, processing, and distribution of food is the largest industry of the world

[1] The Contribution of Atomic Energy to Agriculture, Hearings before Subcommittee on Research and Development, March 31, and April 1, 1954, may be purchased from the Superintendent of Documents, U. S. Government Printing Office, Washington 25, D. C. Price, 25 cents.

today. Therefore, any new development which gives promise of improvement in an important sector of our food economy is bound to have a significant impact on our way of life.

As we listen to this report today, I would like to suggest that we all keep in mind what these developments could mean for the alleviation of food shortages in areas of the world which lack adequate modern transportation and refrigerated storage facilities. We might also keep in mind the unused food surpluses that build up and occur in our country as a result of the existing efficiency of our farmers in contrast with the food shortages in other parts of the world. I think we should also keep in mind that while these studies are making progress we are not just around the corner on this program, and we probably have some distance to go. Perhaps today we can learn how to solve both of these problems in a single stroke.

Our first witness will be Maj. Gen. K. F. Hertford, Chief of Research and Development of the United States Army.

STATEMENT OF MAJ. GEN. K. F. HERTFORD, CHIEF OF RESEARCH AND DEVELOPMENT, OFFICE OF CHIEF OF STAFF, UNITED STATES ARMY

General HERTFORD. Mr. Chairman, members of the subcommittee, ladies and gentlemen: The Army deeply appreciates the interest of the subcommittee in the work we are doing, and feels greatly honored to appear before you today to outline the scope and objectives and some of the prospects for the future that we see. This is particularly appropriate in that the emphasis in this country is based at the present time on some of the nonweapon uses of atomic energy, and we feel that there may be some real contributions.

The development of nonweapons utilization in this field opens a new horizon to the food industry and associated biological activities. The concept of using radiation is by no means a new idea. The impetus to this was given at the end of World War II, particularly by two things, that is, the use of ionizing radiation, which became possible from the Atomic Energy Commission's development, and the development of high energy particle accelerators by industry.

The basic method for sterilizing foods has remained the same for 150 years, since Appert devised, for the Napoleonic armies, the first successful method for canning foods. This is by using heat, and not by ionizing sterilization.

As the chairman stated, the Department of Defense became interested in this subject in 1952, and after a feasibility study, the Department of Defense decided to embark on a program, hoping to make progress enough so that in time industry would take over. The work was assigned to the Army and in turn to the Quartermaster General for the prosecution of the program.

Radiation sterilization employs nuclear ionization instead of heat to destroy or inactivate microorganisms. In this process only a small rise in temperature takes place over a matter of a second or minute as contrasted to heat sterilization, which requires about 240° F. for an hour or more. Radiation sterilization can thus provide a fresh sterile product or a cooked sterile product with far better taste and textures than available from conventional canning and other preservative methods.

I have a photograph showing irradiated versus thermally processed beef tenderloin. These photographs show the meat while fresh, and this shows what happens to the cooked meat that partially disintegrates, and has to be taken in the way it is prepared instead of the fresh form.

Representative VAN ZANDT. May we see that photograph, General?

Representative PRICE. General, for the purpose of the record, that picture shows that the irradiated meat loses none of its freshness or texture as against the processed meat in which something is taken out by heat processing.

General HERTFORD. That is correct. This is a beef tenderloin which normally could be cooked as a steak. A precooked steak would not be as palatable as a freshly prepared steak.

Representative VAN ZANDT. What is the life of the preservation of the food through radiation?

General HERTFORD. I think this will be brought out, sir, by subsequent speakers, as we go through the presentation.

I would like to list and then run over briefly the advantages we see from a military point of view in the radiation sterilization of food.

MILITARY AND CIVILIAN ADVANTAGES

1. Cost reduction in food handling
2. Decrease in refrigeration facilities
3. Decrease in maintenance support
4. Reduction in food losses
5. Improvement in food acceptability
6. Meal-type assemblies
7. Increased use of fresh foods

1. COST REDUCTION IN FOOD HANDLING

The shipping of frozen meat is much more expensive than that for nonperishables. The additional shipping cost imposed by handling of perishables in the frozen state is estimated as tens of millions of dollars per year.

2. DECREASE IN REFRIGERATION FACILITIES

Substantial reduction in refrigeration requirements in the procurement, storage, and distribution of perishable food can be effected. This takes on a special significance for the Army field messes in combat; the Navy aboard submarines, small craft, and other ships; and for the Air crews on extended missions.

3. DECREASE IN MAINTENANCE SUPPORT

The reduction of refrigeration requirements simultaneously results in reduced maintenance costs and operations, thus releasing additional manpower for combat duties.

4. REDUCTION IN FOOD LOSSES

Food losses can be reduced by eliminating the problem of—

(*a*) Insect infestation.

(*b*) Mechanical refrigeration failures.

(*c*) Waste due to food monotony will be minimized by increasing the variety and frequency of serving highly perishable foods which at present are drastically restricted in their utilization due to lack of refrigeration facilities.

The preservation of this might run into millions of dollars.

Representative VAN ZANDT. Does this apply to butter?

General HERTFORD. I think that will be covered, too, sir. I am not the expert in the details.

Representative VAN ZANDT. Will someone discuss it?

General HERTFORD. It will be covered in dairy products.

The above factors bear special importance in view of the $1,500 million magnitude of the annual Department of Defense food budget. In addition, the factors which add materially to the health and morale, and hence, efficiency of the combat soldier are involved. This will be provided by—

5. IMPROVEMENT IN FOOD ACCEPTABILITY

The improvement in acceptability of certain canned ration items which are not well received in the field due to the deleterious effects of current methods of heat processing.

6. MEAL-TYPE ASSEMBLIES

The use of meal-type assemblies for in-flight feeding, box lunches, or even complete meals which can be packaged, irradiated, and held without refrigeration for use in special military operations.

7. INCREASED USE OF FRESH FOODS

Thus it is obvious that the military advantages from the development of radiation sterilization processes are of tremendous magnitude and one which the Armed Forces can ill afford to pass up. However, while the execution of the program is stimulated by its relevance to Armed Forces requirements, the Department of the Army is also keenly aware of the potential benefits to the civilian world. Many of the same advantages indicated for the military offer the same promise to the civilian economy. It may well be that the gains to both the military and civilian food needs will be of the same order of magnitude.

With this as a background I would like to present individuals who will expand upon each of the major elements of the program. Col. W. D. Jackson, Chief, Research and Development Division, Office of the Quartermaster General, will present the project outline and collaborating agencies.

STATEMENT OF COL. W. D. JACKSON, QMC, CHIEF, RESEARCH AND DEVELOPMENT DIVISION, OFFICE OF THE QUARTERMASTER GENERAL, ARMY

Colonel JACKSON. Mr. Chairman and members of the subcommittee, the scope of the Army food irradiation program actually encompasses the following four questions:

1. What radiation sources are available?
2. Are irradiated foods wholesome?
3. Are irradiated foods acceptable?
4. What are the economics of the process?

Subsequent speakers on this program this morning will discuss each one of these questions in detail. I will outline for you the collaborating organizations and the methods by which we are keeping the public informed on this particular progress.

Representative PRICE. Colonel, before you proceed, will you or one of the other speakers give us some idea of what you expect in this human feeding test that is about to begin today?

Colonel JACKSON. Yes, that will be covered by Dr. Kraybill. I think so far each one of the questions that have been brought up are part of the presentation. We hope that we can cover all of those points for you.

At the present time approximately two-thirds of the national effort in this project throughout the country is bracketed within the Department of Army program. We have been especially fortunate we feel in gaining the cooperation and active participation of some 40 research organizations in this project.

On this map (exhibit 1, below, see also list on p. 13) we have shown some of the universities, industrial and other type of nonprofit research organizations and some of the Government laboratories that have contributed to this program, and are continuing to contribute to it. Some of them have been in the field for some time. Some are quite new.

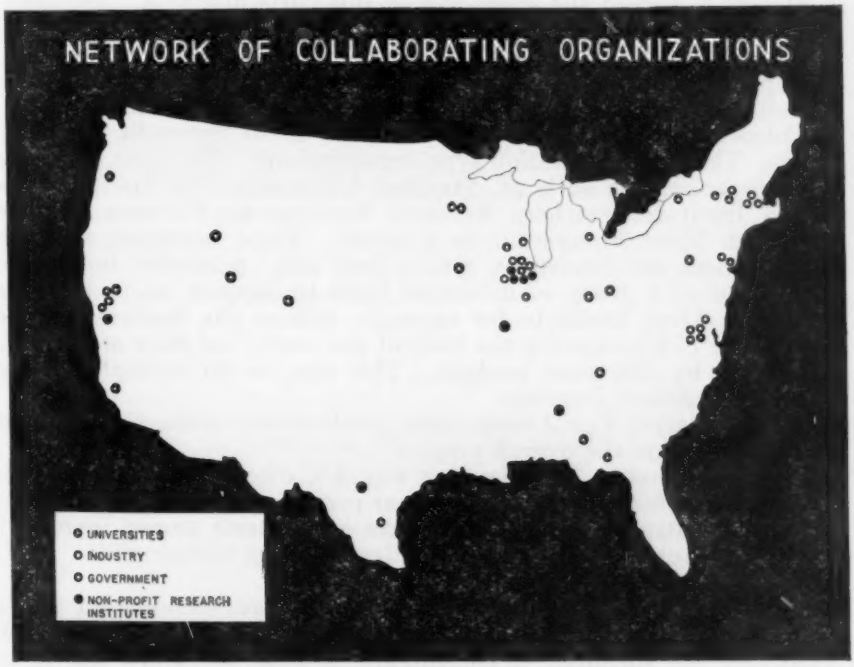

EXHIBIT 1

Just to give you some idea of the sources of irradiation, which is one of the first things we want to discuss, at Cambridge, Mass., we have the source of High Voltage Engineering Corp., and of course the General Electric Co. Research Laboratory in Schenectady, N. Y. Also in Long Island, the Brookhaven National Laboratory of the

Atomic Energy Commission, and in the Chicago area, the Argonne National Laboratory, and out in Idaho Falls, the materials testing reactor, and the Army's own facility at Dugway Proving Grounds, Utah. All of these are large capacity radiation sources and are actively being utilized in this program.

In addition, we also use the General Electric facility at Milwaukee, Wis. Then there are many small sources of ionizing radiation that the Atomic Energy Commission has placed at various universities throughout the country for basic research. We have utilized many of these facilities. You will notice from the chart, the red dots representing the universities, and they are scattered throughout the country, where we can tap the best scientific and technical skills in this program.

The actual coordination of the program is in Chicago. The Quartermaster Food and Container Institute is the coordinator and the center of our program. They schedule the irradiation of those products which have to be shipped to one of the radiation sources, and the samples are then returned to the research facility for evaluation. We are submitting for the record a listing of the universities, research organizations, and industrial companies that are participating with us in this program. I would like to point out that approximately 80 percent of the funds in this program are being utilized for outside contracts to spread the know-how in this particular field. We feel it is necessary for industry to take hold of this project as soon as it is possible.

Representative PRICE. Colonel, the black dots, the nonprofit research institutes, what type of research are they conducting?

Colonel JACKSON. There are several of these nonprofit organizations. They are foundation type organizations. We have contracts with organizations such as, Stanford University, the Stanford Research Institute, Southern Research Institute in Alabama and the American Meat Foundation in Chicago. These nonprofit research organizations are funded by grants from some particular individual benefactor or a group of industrial firms to support research. The American Meat Institute for example, utilizes the facilities of the University of Chicago for the bulk of the work, but they are largely supported by the meat packers. This one, as an example, is the Midwest Research Institute.

Representative VAN ZANDT. How much money is the Government spending now on the overall project?

Colonel JACKSON. The planning estimate considered an obligation rate of $1,125,000 a year over a 5-year period.

Representative VAN ZANDT. Is there any outside money involved?

Colonel JACKSON. You mean is industry doing anything?

Representative VAN ZANDT. Yes.

Colonel JACKSON. Yes, sir. Swift & Co. are spending—I don't know whether that is public information. However, we do know what they are spending—a considerable amount of money and have for several years. The various universities are spending their individual funds. The American Meat Institute also is spending money put in by the various meatpackers. For example, up in this area, Pillsbury are spending their money. General Electric and General Foods are also expending funds in this area. There are a number of

other companies that are spending private capital and it appears to be increasing every day.

Representative VAN ZANDT. From an overall standpoint does it exceed a half million dollars?

Colonel JACKSON. I would say slightly more.

Representative VAN ZANDT. More than a half million dollars?

Colonel JACKSON. Yes, sir.

Representative VAN ZANDT. Can you break it down into numbers? For example, how many universities, how many industrial projects, and how many Government projects?

Colonel JACKSON. I don't have the exact figures. I am informed it is about 25 universities and 15 of the other type of research organizations, industrial and nonprofit. Roughly a total of 45 to 50 collaborating agencies.

Representative VAN ZANDT. Would you say that there are several thousand people involved in this overall effort?

Colonel JACKSON. Yes, sir.

Representative VAN ZANDT. And it has all been coordinated by the Army under the leadership of General Hertford?

Colonel JACKSON. At the present time, yes, sir. The following table lists each of the organizations cooperating in the program at the present time.

COLLABORATING AGENCIES IN FOOD IRRADIATION PROGRAM

GOVERNMENT

Atomic Energy Commission:
- Washington, D. C.
- Argonne National Laboratory, Lemont, Ill.
- Brookhaven National Laboratory, Long Island, N. Y.
- Oak Ridge National Laboratory, Oak Ridge, Tenn.
- Materials Testing Reactor Station, Idaho Falls, Idaho.

Department of Defense:
- Washington, D. C.
- AERO-Medical Laboratory, Dayton, Ohio.
- QM Food and Container Institute, Chicago, Ill.

United States Department of Agriculture:
- Washington, D. C.
- Albany, Calif.
- Beltsville, Md.

INDUSTRY

American Can Co., Chicago, Ill.
Applied Radiation Corp., Walnut Creek, Calif.
General Electric Co., Milwaukee, Wis., and Schenectady, N. Y.
High Voltage Engineering Corp., Cambridge, Mass.
Pillsbury Mills, Minneapolis, Minn.
Swift & Co., Chicago, Ill.
National Canners Association, Washington, D. C.

RESEARCH INSTITUTE

American Meat Institute Foundation, Chicago, Ill.
Armour Research Foundation, Chicago, Ill.
Institute of Vitamin Technology, Chicago, Ill.
Midwest Research Institute, St. Louis, Mo.
Southern Research Institute, Birmingham, Ala.
Southwest Research Institute, San Antonio, Tex.
Stanford Research Institute, Palo Alto, Calif.
Wisconsin Alumni Research Foundation, Madison, Wis.

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UNIVERSITIES

Alabama Polytechnic Institute, Auburn, Ala.
Columbia University, New York, N. Y.
Cornell University, Ithaca, N. Y.
Florida State College, Tallahassee, Fla.
Iowa State College, Ames, Iowa.
Massachusetts Institute of Technology, Cambridge, Mass.
Ohio State University, Columbus, Ohio
Oregon State College, Corvallis, Oreg.
Pennsylvania State University, State College, Pa.
Texas A. and M. College, College Station, Tex.
Union College, Schenectady, N. Y.
University of California, at Berkeley, Calif.
University of California, at Davis, Calif.
University of California, at Los Angeles, Calif.
University of Chicago, Chicago, Ill.
University of Colorado, Denver, Colo.
University of Illinois, Urbana, Ill.
University of Massachusetts, Amherst, Mass.
University of Michigan, Ann Arbor, Mich.
University of Minnesota, Minneapolis, Minn.
University of Rochester, Rochester, N. Y.
University of Utah, Salt Lake City, Utah
University of Wisconsin, Madison, Wis.

Representative PRICE. What sort of physical properties would you envision that a packing company or a general food company would eventually require to irradiate their products?

Colonel JACKSON. What kind of packaging?

Representative PRICE. What type of plant facilities?

Colonel JACKSON. On this chart over here, we have three different type of plants (exhibits 2, 3, and 4, pp. 15, 16, and 17). I know you cannot see from where you are sitting, because they are on the bottom row. One type of plant would process potatoes. The potatoes would come into this plant and out into the trucks to be hauled away, because it is a rather quick process. We can process grain which is another very high volume item. We would have to locate a portable plant, a boxcar or something of that sort. We have worked with the Atomic Energy Commission and it is entirely feasible to put a reactor, isotope type fuel element source in such a facility. We don't know at this time exactly what type of equipment we need to do this. We are still in the research stage. It is possible to put a very small machine that will do quite a large volume of work at various localities.

In the meat-packing industry it could be put in the packing plant as part of their equipment. Where you would have large volumes of fruits and vegetables it would be a part of a large conveyor system. It is not too cumbersome if that is what you are getting at. The shielding that is necessary for the protection of the operators and general public really is the limiting point.

Representative PRICE. But even in a large operation it would not require the construction of a large reactor such as you have at Hanford.

Colonel JACKSON. No, sir; by no means. Actually we had planned some time ago for a facility in a truck—a large van truck, and also in a boxcar.

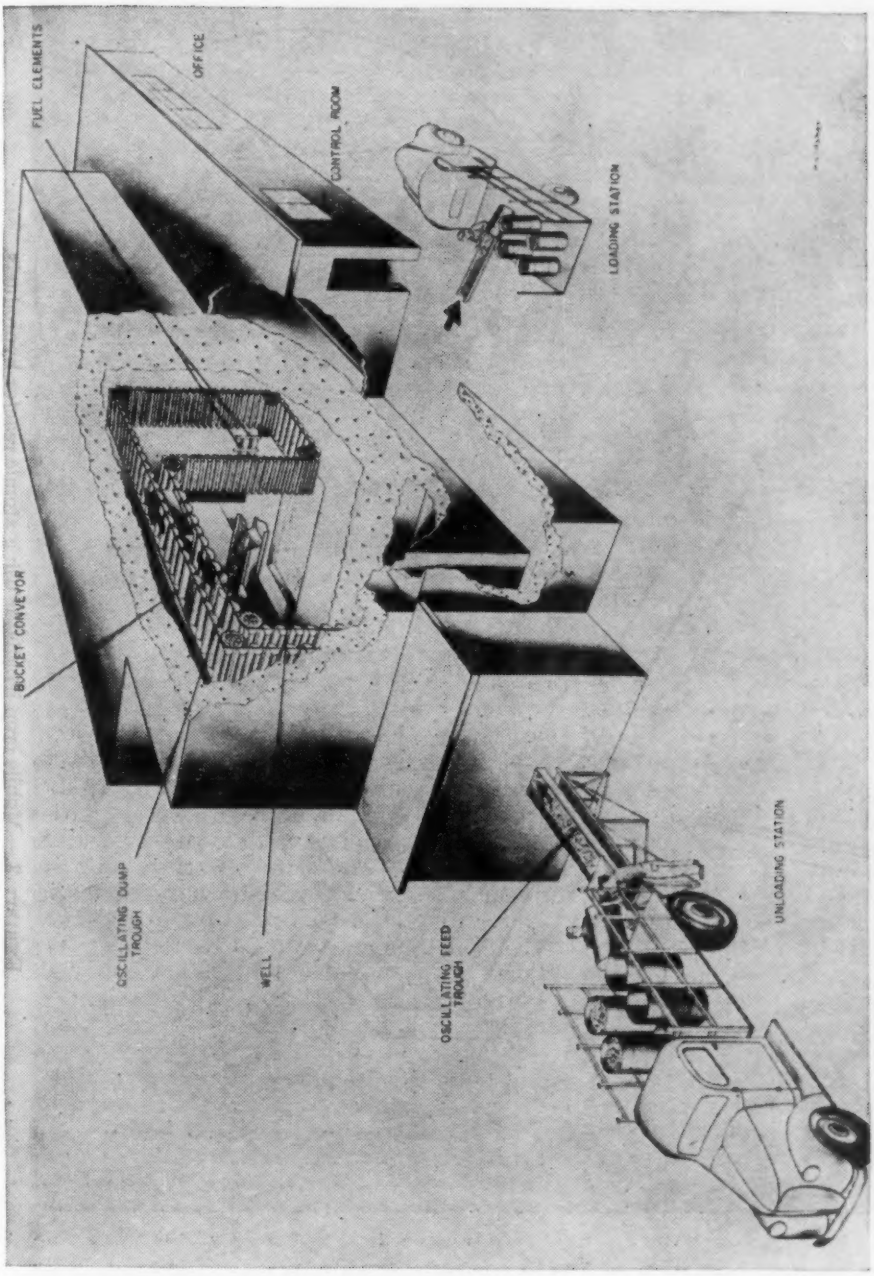


EXHIBIT 2.—Potato irradiation facility using spent fuel elements or radioisotopes.

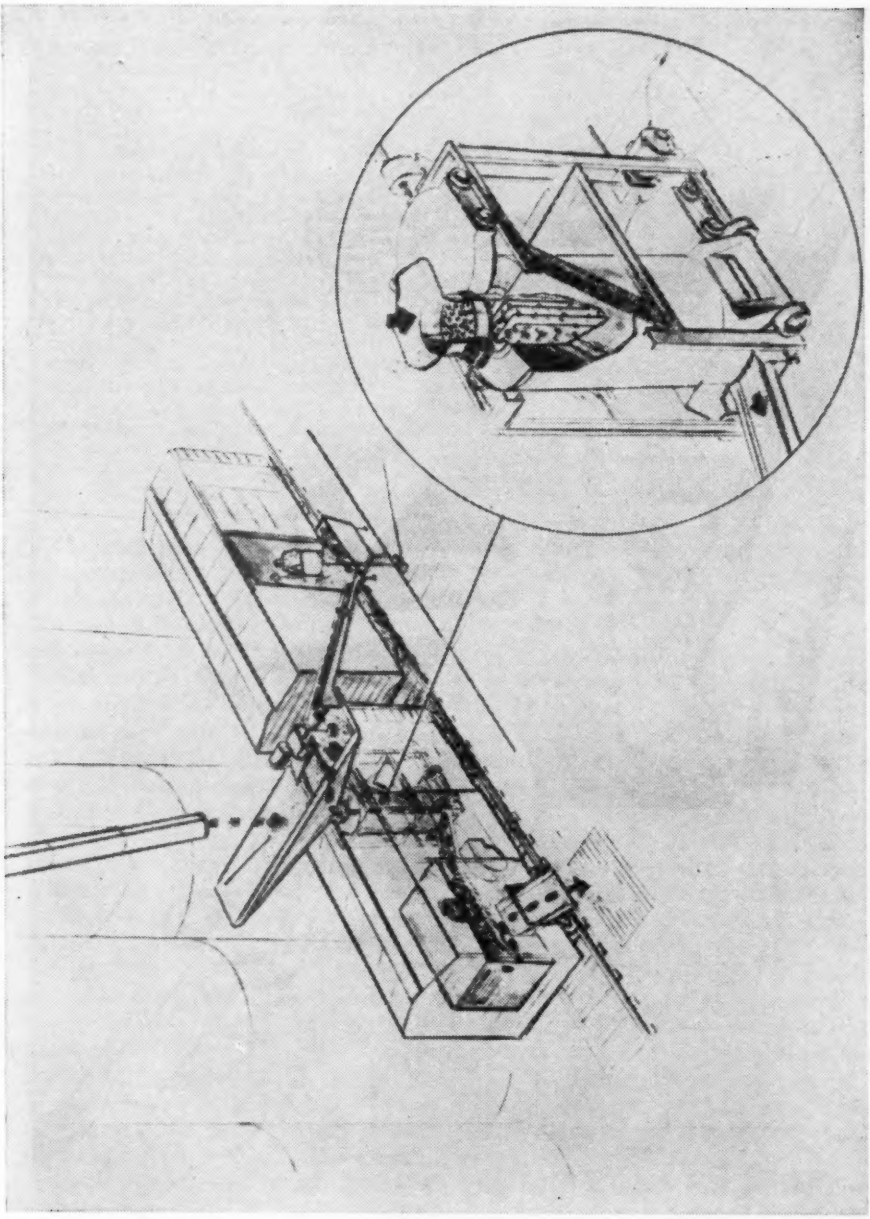


EXHIBIT 3.—Mobile crop irradiator using atomic reactor byproducts.

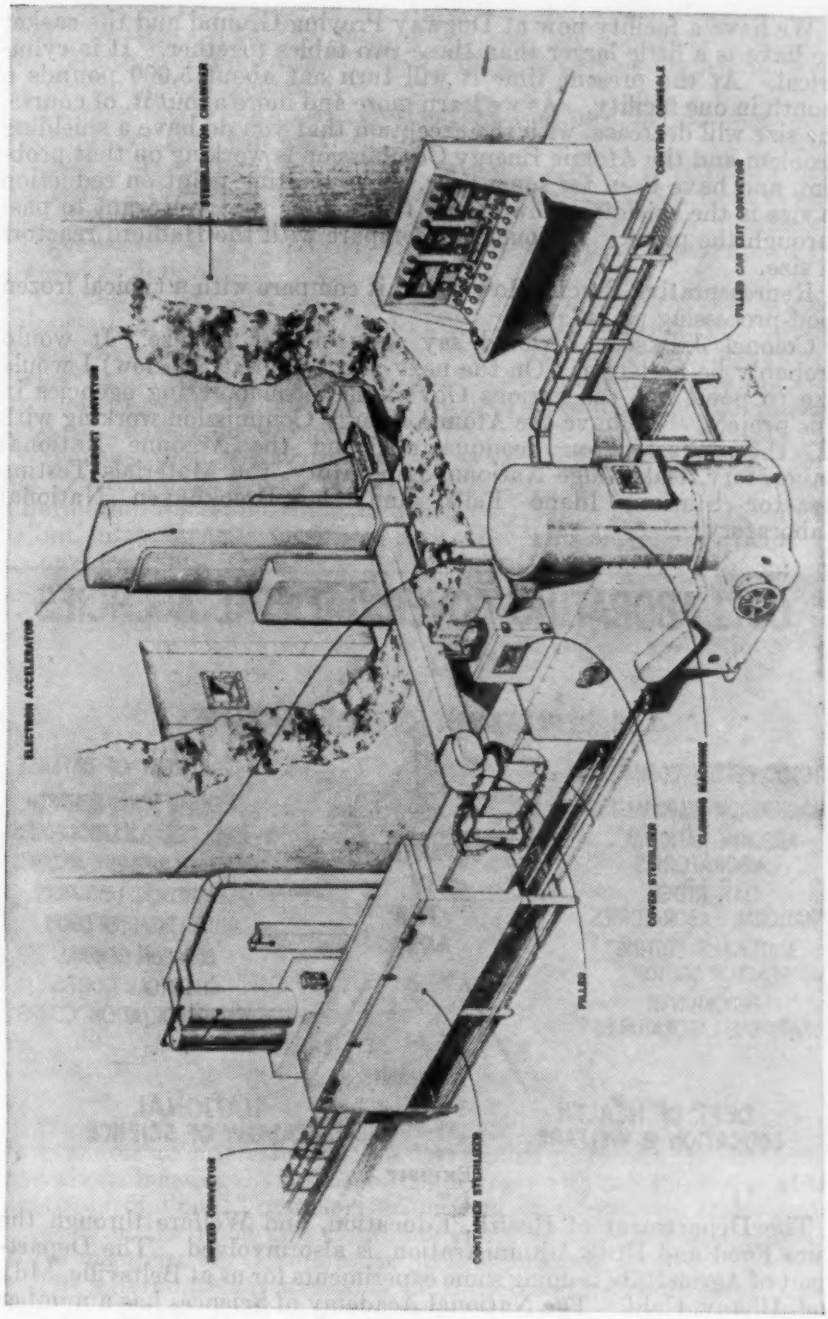


EXHIBIT 4.—Aseptic canning, cold sterilization line using linear acceleration.

We have a facility now at Dugway Proving Ground and the casket we have is a little larger than these two tables together. It is cylindrical. At the present time it will turn out about 5,000 pounds a month in one facility. As we learn more and more about it, of course, the size will decrease, with the exception that you do have a shielding problem and the Atomic Energy Commission is working on that problem, and have been for some time. The limiting point on reduction in size is the shielding, power, and the volume that you want to pass through the plant. It would not compare with the Hanford reactors in size.

Representative PRICE. How would it compare with a typical frozen food-processing plant?

Colonel JACKSON. I would say very similar in size. It would probably be no larger. On the next chart (exhibit 5, below) I would like to point out the various Government collaborating agencies in this project. We have the Atomic Energy Commission working with us, their Washington headquarters, and the Argonne National Laboratory, Oak Ridge National Laboratory, the Materials Testing Reactor Station, Idaho Falls, and the Brookhaven National Laboratory.

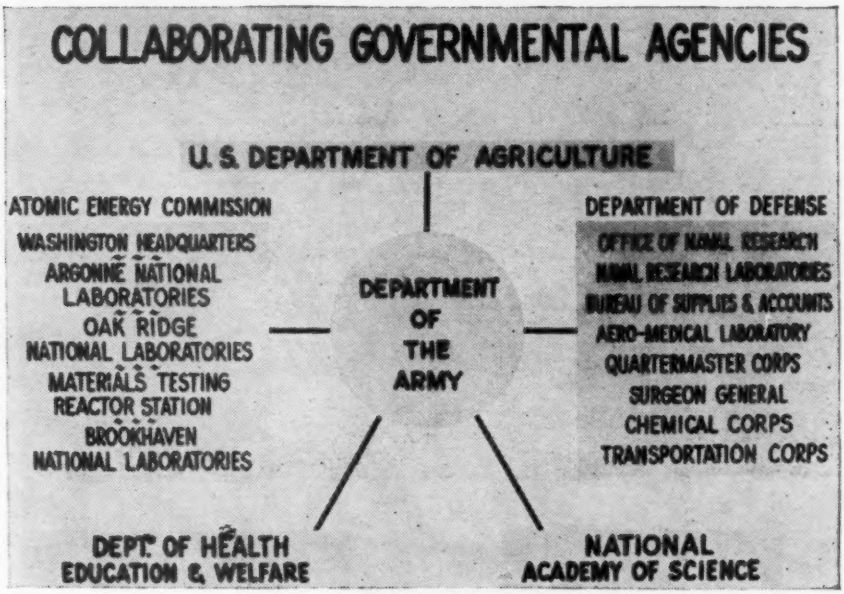


EXHIBIT 5

The Department of Health, Education, and Welfare through the Pure Food and Drug Administration, is also involved. The Department of Agriculture is doing some experiments for us at Beltsville, Md., and Albany, Calif. The National Academy of Sciences has a number of committees that are lending technical assistance to us in the solution of these many problems.

In the Department of Defense, the Office of Naval Research and the Naval Research Laboratory are assisting us by their work in dosimetry. The Bureau of Supplies and Accounts is assisting us, the

Aero-Medical Laboratory of the Air Force, and within the Army, the Quartermaster Corps, the Surgeon General, the Chemical Corps and the Transportation Corps. All of these are assisting us in their particular field of endeavor.

Representative VAN ZANDT. What is the meaning of the word "dosimetry" that you use?

Colonel JACKSON. Dosimetry is actually a word that means dose metering. It is the amount of reps that the particular item is subjected to. The measurement of amount of rays is called dosimetry.

Representative VAN ZANDT. In other words, it is a measure of the dose of radiation?

Colonel JACKSON. That is correct. It is a measure which is quite important in our research work to know exactly how many thousands or million reps we have subjected an item. It will become increasingly important in commercial application. You would have to know that you have a sterilized product or pasteurized product, and the method of measure is called dosimetry.

Realizing the importance attached to keeping industry, science, and the general public abreast of this program, we have developed a public information release mechanism which we think will permit broad distribution to agencies interested and those who may be participating in our program. (Exhibit 6, below.) For the benefit of the general public we have periodic press releases. We also have sent out certain semitechnical progress reports. For technical publications we have made a number based on conferences and symposia that we have held and also the status reports of our contracts.

DISTRIBUTION OF INFORMATION

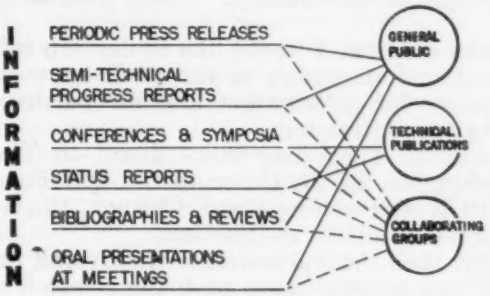


EXHIBIT 6

We have also made a study and review of all the literature. This is available to interested people. We have made oral presentations at various meetings. Next month there are two meetings, one at the Institute of Food Technologists meeting at Columbus, Ohio, and a meeting of the Food and Container Associates in Chicago. Both of those meetings will devote a day to this program.

The information is available at those meetings and open to the public. However, we take this information and condense it for dissemination. Technical publications are evaluated before publication. Sometimes the contractor may be working in one particular area, but to make sure it fits into the whole program, they are technically evaluated and integrated with other research information and thus

become part of the semitechnical reports which are available for the asking. We have not distributed too many up to this time but we feel we will in the future.

Representative VAN ZANDT. Colonel, have you had many requests for information from business in general throughout the country?

Colonel JACKSON. Yes, sir. We have not had too many requests from academic institutions. Most of them have been from commercial sources, people that are either in this particular area by working with AEC or something of that nature, or our food processors. General Mills, General Foods, Pillsbury, Swift & Co., Wilson—all the packers—all the canners. We have had a number of meetings with them. We have published the reports of the meetings, and they have obtained these reports through their own organization. We frequently get letters from new ones. I know the Maine potato growers have contacted us. Requests here come from all over the country.

Representative PRICE. How would a small food manufacturer inquire into this food-sterilization program?

Colonel JACKSON. At the present time they can write direct to the QM Food and Container Institute at Chicago and get the information. We plan to have a better way of disseminating this information as we accumulate more information. We would like to have it published and then available from the Government Printing Office as a pamphlet.

Representative PRICE. Is it possible for a small food manufacturer to send any of his personnel to any of the laboratories working on these experiments?

Colonel JACKSON. Yes. We have visitors at the QM Food and Container Institute. There will probably be closer facilities at some of the universities. From the map you can see they are scattered generally throughout the country. There is nothing classified about this project.

Representative PRICE. I would like to develop information for the benefit of food manufacturers so they will know whom to contact and where to go for information and for participation in such a program if they are interested.

Colonel JACKSON. They may write direct to The Quartermaster General, Washington 25, D. C., or to the QM Food and Container Institute, 1819 West Pershing Road, Chicago, Ill., where the bulk of the information is available at this time.

In summary, then, let me reiterate the overall orientation of our program. We are attempting to push the research and development of this intriguing process over the technological hump so that American industry can take over at the earliest possible date, and I am sure that is what you were referring to in your questions.

We recognize that military departments can do little with a process of this type unless American industry does take over. From the very inception we recognized that, and have published as much material as we can. Of course, as the project grows, and more information is available, we can pass it on much more rapidly than we have in the past. We have activated this information release mechanism which we think will give the public and industry all the evaluated information available.

Representative PRICE. In other words, you are ready for the participation of any food manufacturer.

Colonel JACKSON. Yes, sir; we are anxious to have them participate with us.

Representative VAN ZANDT. Colonel, a moment ago you told us that you are spending about $1,125,000 annually.

Colonel JACKSON. We are currently spending about a million dollars a year, sir.

Representative VAN ZANDT. And industry is probably adding to that something in excess of a half million.

Colonel JACKSON. Yes, sir.

Representative VAN ZANDT. In your opinion has the Congress appropriated sufficient money for you to carry on this program, or do you think that you are being restricted for lack of funds?

Colonel JACKSON. At the present time I would say we are amply funded. As the process becomes more promising and we get it a little more out of the research stage, then we will probably have to ask for additional funds. General Hertford could probably answer that question better than I could.

Representative VAN ZANDT. I would like to have General Hertford comment on the question.

General HERTFORD. Yes, sir, we consider that there are sufficient funds at the present time. If there is a breakthrough or something that warrants additional funds, the first thing we will do is to look for it in the funds available to us. We have a research and development appropriation, and the first thing we will try to do is to reprogram funds from among our own projects, research and development, Army-wide. If we cannot do that, and if it is really a significant breakthrough, then in the next year's appropriation we will ask for additional money.

Representative VAN ZANDT. Could you give us some indication when you anticipate a breakthrough?

General HERTFORD. It is a very difficult thing to predict breakthroughs in research and development, Mr. Van Zandt. We feel encouraged in this program, and after you hear the rest of the presentation, you will see we are optimistic.

As far as predicting, in the biological field you have tissue as well as mechanical things to work with.

Representative VAN ZANDT. I look forward to the presentation, but I am concerned now with the development of these foods, not alone for the benefit of the public, but also for the military, because I know what it will mean to our Defense Establishment in the near future.

Let me ask you this question: Is there any limitation on your efforts in this field in regard to expanding your organization, which naturally would mean spending more money?

General HERTFORD. No, sir. There is no limitation on that. As Chief of Research and Development, I have to look at the overall research and development program. General Hastings, who is charged with this program, might come in and say "I need more money, and I have to have additional facilities." If it seems justified to us, based on the overall picture, then we will give it to him.

Representative VAN ZANDT. Is the money involved here just part of the general appropriation for research and development?

General HERTFORD. Yes; that is correct.

Representative VAN ZANDT. Or is it earmarked for research and development in this particular field?

General HERTFORD. No, sir; it is part of the appropriation, research and development. The Army itself has a Research and Development

Review Board which makes the allocation of a certain amount of money to the Quartermaster General for this particular purpose. There is no reason why we cannot take it away from other areas of the Army research and development appropriation and put it on this project.

Representative VAN ZANDT. In turn, they can take it away from this project if they wish?

General HERTFORD. That has to go through my office.

Representative VAN ZANDT. That is the point I am trying to develop. Are you sure now that they are not going to take any money away from you and you have a free rein to give leadership to this important project?

General HERTFORD. I am convinced of that as long as I am there.

Representative VAN ZANDT. What we are thinking of, General, is that we want a Rickover in the Army as far as this project is concerned. I am sure you understand what I have reference to when I say we want a Rickover.

General HERTFORD. Yes, sir. Maybe General Hastings can add to that, because he is our technical adviser. I am sure if he had a reason and a breakthrough on something promising, we would put more money on it. You realize that also all our projects are coordinated under the Department of Defense. This being more of a tri-service project, we do coordinate with Dr. Quarles, who has an advisory panel which tells us he feels we are putting enough emphasis on it or too much, as the case may be.

Representative PRICE. How important does the Defense Department consider this project?

General HERTFORD. I do not know how to answer that qualitatively. Mr. Quarles thinks it is quite important. We have included it in several presentations to the committee. It is one of our more important projects. I can put it that way. We have a lot of others, too, in other fields. But this is one of our more important projects.

Representative PRICE. One that has high priority in the services and the Defense Establishment.

General HERTFORD. I am not sure whether it has an A–1 priority, which is listed as something that is vital to win a war. General Hastings, has the project been held up because of lack of priority?

General HASTINGS. No; I don't think it has. We place a great deal of emphasis on this one project. It is perhaps our No. 1 in all QM research. I think that over 50 percent of all our food-research money is going into this one project alone. We do not want, of course, to undertake it on a crash basis. We can go off on tangents and throw away a great deal of money. We are doing it in a very orderly way. Right now we feel that the funds are ample for the year. What the future has in store for us, we don't know right now. With the emphasis that is being placed upon it, we feel quite secure, and we want to feel very secure, and we appreciate the tone of your questioning to establish that security, because of its importance.

Representative PRICE. General, when you say you are putting half of your funds into this project, it indicates the importance that you attach to it.

Representative VAN ZANDT. Mr. Chairman, may I add that both General Hertford and General Hastings will understand our feeling as a committee in regard to this project, because we want to leave no

stone unturned to reach that day when that breakthrough will be accomplished. We understand the value of this project not only to the American people as a whole, and to the peoples of the world, but especially to the military branch of our Government.

General HERTFORD. We are deeply appreciative of that.

Representative PRICE. Colonel?

Colonel JACKSON. You were asking several times about industry's contribution. We have a rather unique mechanism that might be of interest. We have made contracts with several food-processing firms that have their own large research laboratories to utilize that talent. We have formed agreements with these companies utilizing our sources of radiation to irradiate the food for them. They do the research work in the particular field that they are interested and furnish us with the information which then is open to the public. I think that encourages industry to utilize our gamma source as there are no industrial sources for the use of atomic-energy products available to them at the present time. They have not made the applications. We have one of the first licenses for the release of this material that was provided under the Atomic Energy Act of 1954. We have made agreements. We have three of them at the present time. By that means we are using their research organizations.

We expect to have industry take over this project just as rapidly as we can possibly do it. That is really the picture that I have tried to paint for you this morning.

Representative PRICE. What type of license does the Army have?

Colonel JACKSON. We have a license from the Atomic Energy Commission for 1,200 grams of U–235. That will be explained by Mr. Horner from the AEC, who is here this morning as a part of this presentation.

Representative PRICE. Does that conclude your testimony?

Colonel JACKSON. Yes, sir.

Representative PRICE. I think this might be a good point to ask a few questions in connection with your international relations in this particular field.

Is it planned to include this program among those to be discussed at the International Conference on the Peaceful Uses of Atomic Energy at Geneva, Switzerland?

General HERTFORD. Yes, sir; it is. This is included. We are sending exhibits and a representative from the Army is going over.

Representative PRICE. Is there any indication of what Great Britain and Canada are doing along these lines?

General HERTFORD. As far as I know, sir, they have been following what we have been doing since it is completely unclassified information. But I do not know what is being done specifically.

Representative PRICE. We are not working with them in any way on this type of program?

Colonel JACKSON. Perhaps I could answer that. The Canadians are not doing anything on this particular project. They are taking our reports, and we have a free exchange of information with them.

The British, however, are now studying whether they should go into this field as a research project, and we have furnished them quite a bit of information, and it is to be decided very shortly in their Government. I think it would have been decided a little sooner if they had not changed the Government. They felt it was so important

that it had to get up to the Cabinet for decision before they would turn it down. They have not decided to come in, but they look very favorably upon it.

We furnished information to them. They probably will join in. They have not at this time. They are seriously considering it.

Representative PRICE. This program is concerned almost entirely with unclassified information. There would be no restriction from the Commission to hamper the program in any way; would there?

Colonel JACKSON. We have had none. We have our own facility at Dugway. We have had free access to their facilities at the materials testing reactor, and at Brookhaven reactor, wherever our people have been working directly in the project we have had fine cooperation from the Atomic Energy Commission. There has been little difficulty.

General HERTFORD. If there are no further questions, sir, I would like to introduce Captain Pomerantz, who will discuss the beta type of radiation which we are experimenting with in addition to gamma radiation. He is the radiation sterilization officer at the QMC Food and Container Institute.

STATEMENT OF CAPT. REUBEN POMERANTZ, QMC, RADIATION STERILIZATION OFFICER, QMC FOOD AND CONTAINER INSTITUTE FOR THE ARMED FORCES

Captain POMERANTZ. Mr. Chairman, members of the committee, ladies and gentlemen: There are two types of ionizing radiation which are of specific interest to the Army's program. These are the gamma radiations and the electron beams. Gamma radiations are high intensity electromagnetic waves which are produced within the nucleus of an atom. They can either be manufactured or produced by manmade generators in the form of X-rays, or they are emitted by certain naturally occurring radioactive materials and radioisotopes. Electron beams are also available from certain naturally occurring elements and from radioactive isotopes. However, the type of high intensity electron beams which are of interest to our program are those which are available from manmade accelerators.

At the present time it is still not clear as to which type of radiation, gamma or electron, offers the greatest potential for our use. Therefore, the Army has devoted a very specific aspect of its program to the evaluation of the various types of gamma and electron sources in the hope of determining as soon as possible which form or perhaps forms hold the greatest potential for the food processing industry.

Since my discussion will be followed by a presentation by Mr. Horner of the Atomic Energy Commission on the gamma sources of radiation, I would like to limit my remarks to those types of machines which have been specifically designed to produce high intensity electron beams.

The velocity to which the electrons are accelerated is probably one of the most primary considerations since it will determine the depth of penetration which the electrons will have into the product being treated. When we deal with food sterilization, where we like to get penetration of electrons throughout the item being treated, we must be concerned with millions of electron volts.

The first classification of generators which I would like to discuss is the so-called direct generators. These involve in addition to the

electron beams—the source of electrons for the beams—a very high voltage source to accelerate the electrons to the required speed in order to penetrate the particles being treated.

The first machine which I will discuss is the so-called resonant transformer. (Exhibit 7, below.)

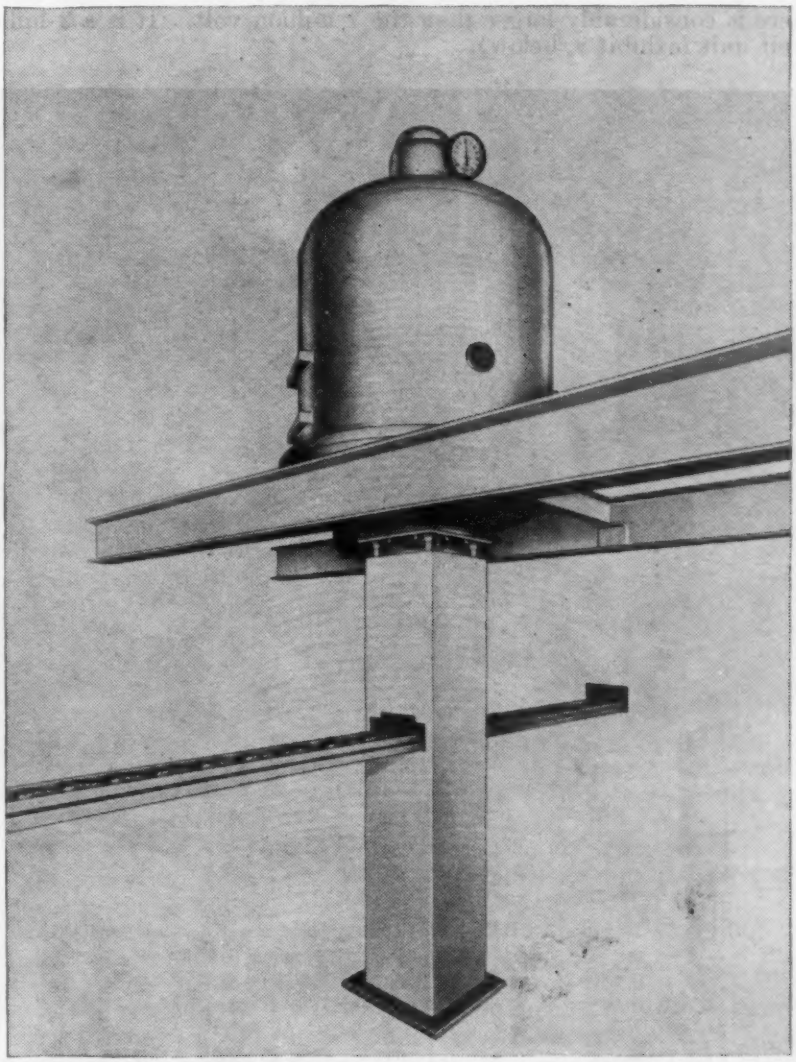


EXHIBIT 7.—One million volt resonance transformer.

This is manufactured by the General Electric Co. X-ray division, and it is a 1 million volt electron generator. This is a modification of the conventional type X-ray therapy unit. What we have done is replace the heavy metal target normally positioned here, which converts the electrons which are emitted from the tubes to the X-rays,

and placed instead a very little metal window. This permits the electrons to pass directly through the window on to the belt where our product is being treated.

Another type of electron generator which is widely used in our program is the Van de Graaf accelerator manufactured by the High Voltage Engineering Corp. in Cambridge, Mass. The unit shown here is considerably larger than the 1 million volt. It is a 3 million volt unit (exhibit 8, below).

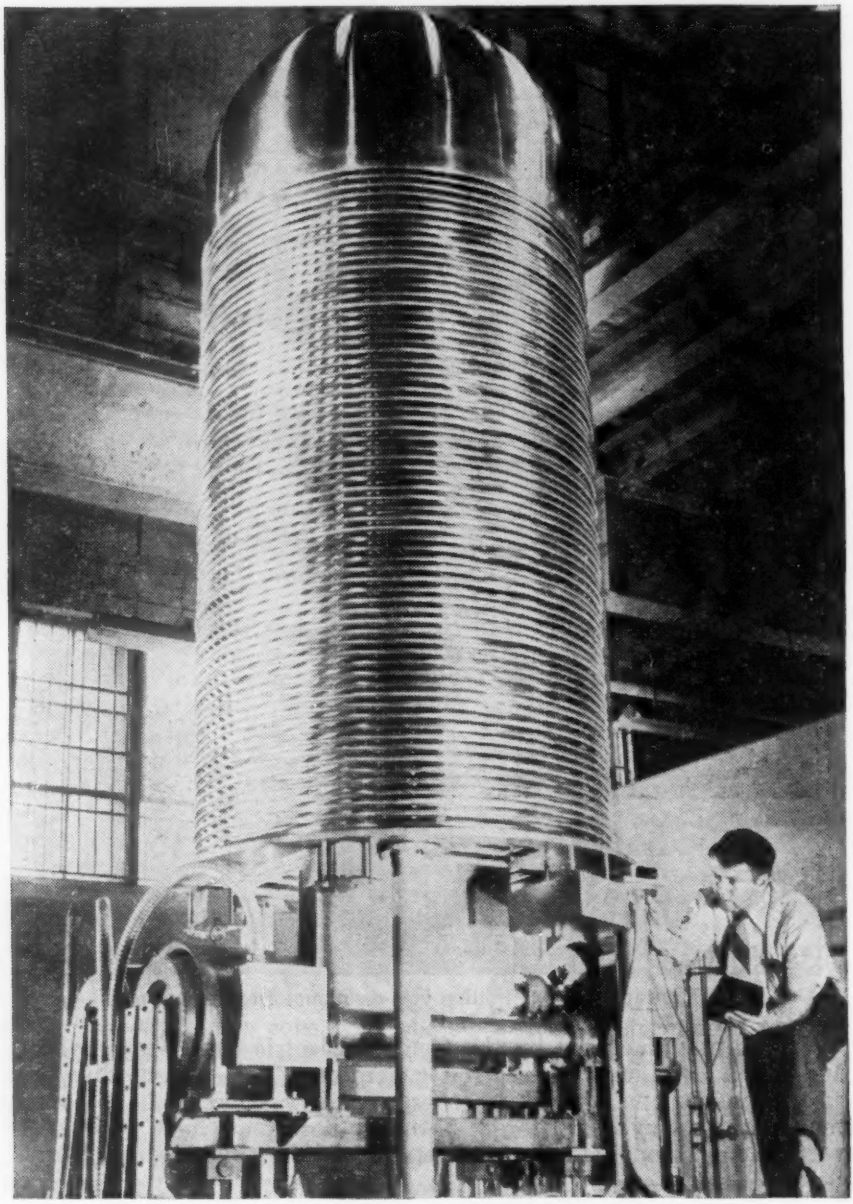
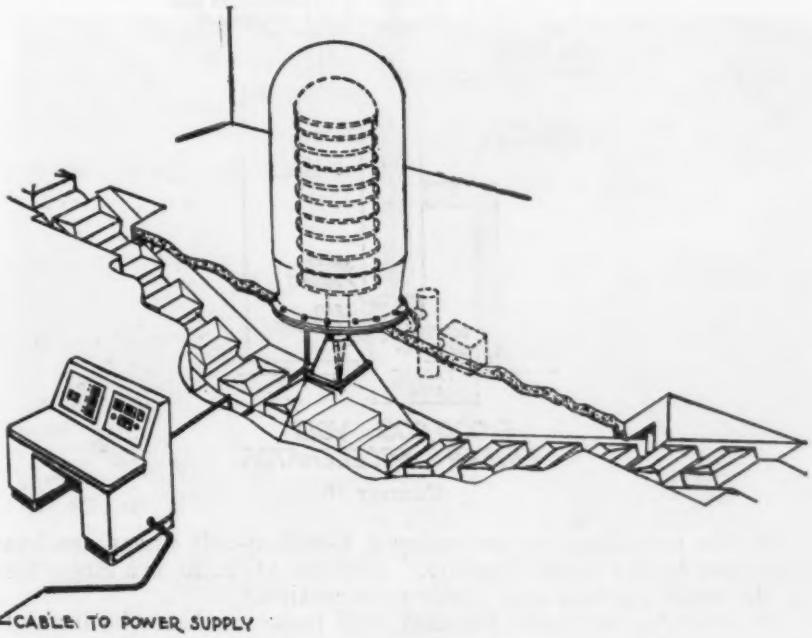


EXHIBIT 8.—Van de Graaf accelerator.

Still another approach to obtaining the high voltage required to accelerate the electrons is the design of the capacitron (exhibit 9, below).



2 MILLION VOLT CAPACITRON

EXHIBIT 9.

This is a unit conceived and manufactured by the Electronized Chemical Corp. of Brooklyn, N. Y. It is a 2 million volt capacitron. This model shows the artist's drawing of the new machine under construction and which should be available for use some time early this summer.

The direct types of generators which I have just discussed, due to the heavy requirements for insulation and as you noted, the size, as we get up into the high energy ranges, it appears will not be feasible to build direct type generators above the energy level of approximately 5 million electron volts. The electron people have focused considerable attention of late on the so-called indirect accelerators such as the linear accelerator. This type of equipment employs high frequency power instead of high voltage to give the electrons the necessary acceleration and speed. Thus we eliminate the problems associated with insulation and high voltage sources.

The unit shown here (exhibit 10, p. 28) is a linear accelerator developed by the Applied Radiation Corp., a relatively new concern, in Walnut Creek, Calif. This is a 6-million-volt accelerator. It is in the final stages of production and we hope to employ it some time this summer.

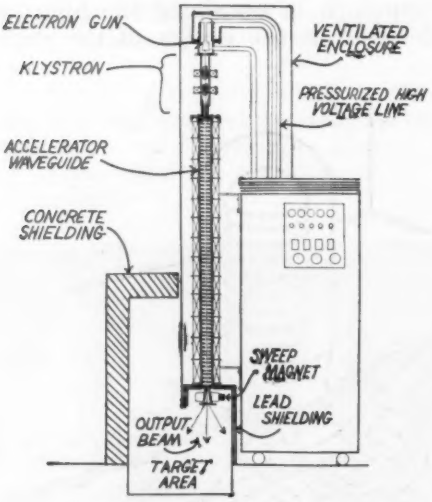


EXHIBIT 10.

In the meantime we are using a 2-million-volt linear accelerator produced by the same company. (Exhibit 11, p. 29, is a larger model of the same machine now under construction.)

Representative PRICE. Captain, will these machines be limited to special radiation uses, or do you have reason to expect that they will be available for general use at low cost to irradiate food?

Captain POMERANTZ. I will get to that a little later in my presentation, but I would like to point out at this time to directly answer your question that we foresee the electron machine as of limited use rather than universal use in the food field as the picture looks today, primarily because of the penetration problem. Even with the 6-million-volt generator, we are dealing with something between 1 and 2 inches. If we start to think of a side of beef we must deal with many, many, inches, and to date there are no machines that can penetrate to that depth, as we point out when we evaluate the gammas versus the electrons.

I would like to point out also at this time that the generators which I have discussed and the ones currently available on the market are producing an output in the range of a half a kilowatt to 12 kilowatts of power. This provides us with sterilization capacities of the order of 50 to perhaps 3,000 pounds per hour. This obviously does not come close to production-rate capacities.

Representative VAN ZANDT. May I ask a question at this point?

Captain POMERANTZ. Yes, sir.

Representative VAN ZANDT. Concerning the output beam, is the food exposed to the beam without any covering whatsoever?

Captain POMERANTZ. The only covering would be the packaging material that might be on the food itself.

Representative VAN ZANDT. In other words, you could package the food first, then put it on a belt and expose it to the beam, to have it irradiated?

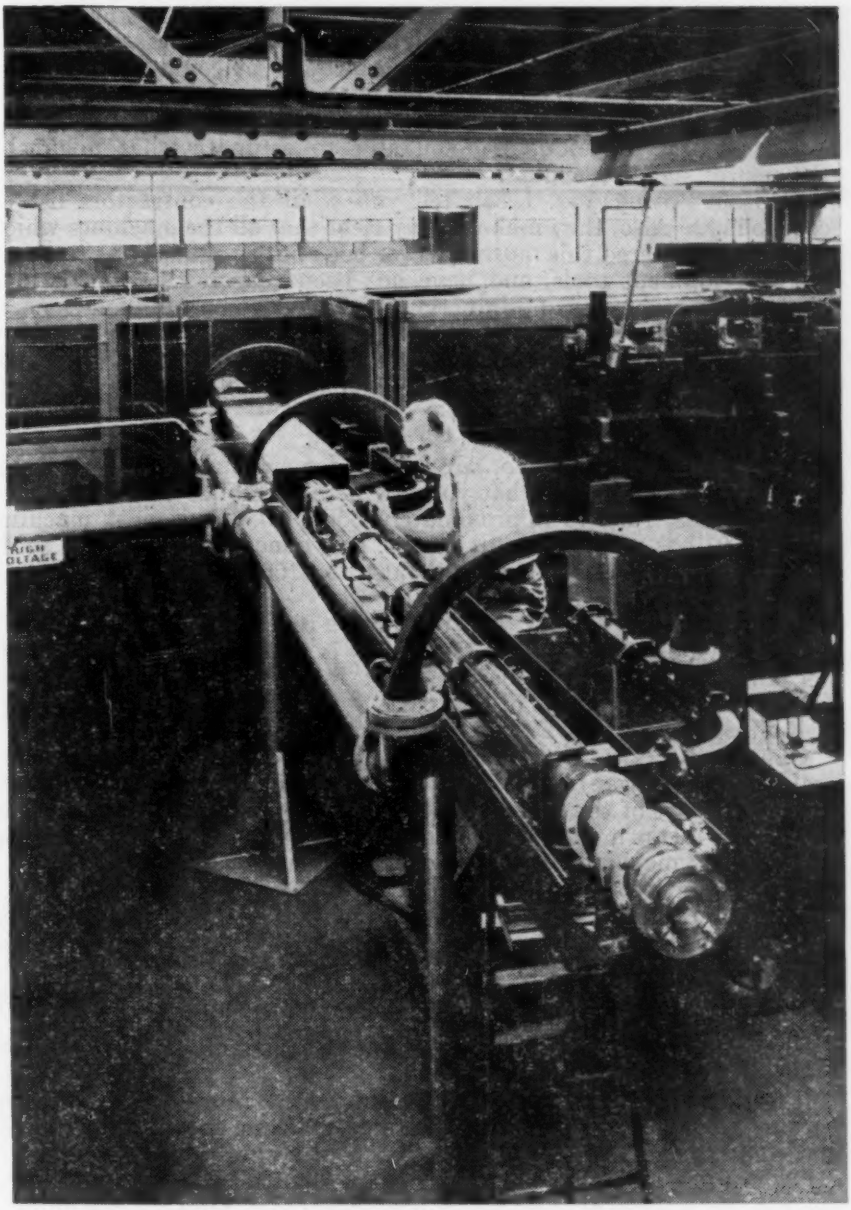


EXHIBIT 11.—Fifty-million-volt linear accelerator.

Captain POMERANTZ. That is right. The reason we like to have the product packaged is because any of these products are subject to reinfestation or contamination and rather than handle it by the human hand, once it leaves the radiation machine, we might as well have it prepackaged. If you are dealing with low moisture, where you do not have a problem, you might let it go in the dry stage or even have some sort of septic canning device where you could have the food pass through first on the belt outside of the container, and then under sterile conditions package it at the end of the line. (Exhibit 4, p. 17.)

Representative PRICE. Are you able to estimate what might be the cost of such a machine?

Captain POMERANTZ. I can tell you what the contractors list as cost today. Also, they make it very clear that all the machines which we have considered this morning have been built primarily as research and development tools, and have not been conceived with the idea of attaining high rates of production efficiency. The 1 million General Electric machine first shown to you is not for sale (exhibit 7). It is on a rental basis of approximately $22,000 per annum. The High Voltage Engineering Corp. makes a 1-million-volt accelerator which sells for approximately $50,000.

Representative PRICE. That is rental?

Captain POMERANTZ. No, sir; that is for sale. It is a very small compact unit. The one that you saw here (exhibit 8), the 3-million-volt machine, runs to approximately $500,000. This next machine (exhibit 9) has not been built as yet, and none have ever been sold. They are quoting estimates of $135,000 to $150,000 for the 6-million-volt linear accelerator. (Exhibit 10.)

Representative VAN ZANDT. Would you repeat those figures please?

Captain POMERANTZ. This (exhibit 7) is available today at $22,000 per annum on a rental basis. That includes service by General Electric and replacement of any part.

Representative VAN ZANDT. Now we come to exhibit 8.

Captain POMERANTZ. This is a 3-million-volt unit with a considerably higher power output than the one originally shown. Actually this is one part of the machine. This is the powerplant. This takes two floors. Down below we have the scanning device, and conveyor belts. This machine costs approximately half a million dollars.

Representative VAN ZANDT. What is the next one, exhibit 9?

Captain POMERANTZ. This unit has never been built and there is no cost estimate available to us today.

Representative VAN ZANDT. What about exhibit 10?

Captain POMERANTZ. That unit will not be for sale either. It is for use of the company for research.

They are quoting today as being able to make one similar to it for approximately $130,000 to $150,000.

Representative VAN ZANDT. The differential in cost as I see it is because they are using a standard X-ray machine shown in exhibit 7 and converting it.

Captain POMERANTZ. That is right. General Electric, however, recently announced at their electron symposium in Milwaukee a month ago that they are going into a larger capacity-type transformer that is a complete new design and not a modification of X-ray machines. No costs are available to us at this time.

I want to finish one other thought, and that is on the power output. To get the pounds per hour that a commercial company would be interested in—and we are now talking about many tons per hour—we must manufacture generators which have a power output of 40 to 60 kilowatts. As I mentioned, we are now working on the largest one that we know of today which is a 12 kilowatt. So we are still a long way from the 50 or 60 which might be required.

Using the following table, I would like to indicate some of the characteristics of the electron and gamma sources, and indicate the major advantages and limitations of the two types of equipment.

Characteristics of radiation sources

Characteristic	Electrons	Gamma
Penetration (1 Mev)	⅛ inch (single pass)	15 inch (half thickness).
Utilization efficiency	High	Low.
Energy distribution	Nonuniform	Uniform.
Treatment rate	High for thin layers	High for thick layers.
Ease of operation	Simple	Complex (reactors); simple (isotopes).
Safety requirements	Minimum	Significant.
Bactericidal action	Equally effective	Equally effective.
Sensory changes	No apparent difference	No apparent difference.
Technical personnel required	Few	Many.

Here again as I pointed out under "Penetration," taking a 1 Mev. unit as a standard, we have an electron penetration of approximately one eighth of an inch. You can see there we are dealing with a very, very small thickness. However, we can use a double pass—passing the article through once and turning it over and hitting it on the other side, or perhaps having 2 units simultaneously, 1 on the top of the product and 1 below—and get double or two and a half times the one-eighth of an inch. By giving the double pass you get more than double penetration. You get two and a half times.

On the gamma, however, using a 1 Mev. we can go through 15 inches of material of unit density such as water, and still have half of the original intensity of the beam left. You can see there the tremendous difference between our penetration problems.

Utilization efficiency; under electrons it is relatively high. With a double pass or using 2 accelerators, we can get efficiencies of the order of 60 to 75 percent. In our gamma efficiencies we are very low. As you know, in a power reactor, we have just a matter of 2 or 3 or perhaps 5 percent maximum of the power available to use in the form of gamma energy.

Energy distribution in the electrons is relatively nonuniform. In the gamma we have a uniform distribution of the radiation throughout the product. This is of prime importance, because with nonuniform energy distribution, we may have certain areas of the product which receive too great a treatment, and other areas undertreatment.

Treatment rate for electrons is very high for thin layers and the same for gamma with thick layers. Ease of operation; the electrons are relatively simple. I am not considering here maintenance of the

machine. I am talking about operation. It operates with one man on the panel board, and you can push the switch off and on. The gammas are rather complex when we deal with reactors. With isotopes sources they too are relatively simple.

Safety requirements are at a minimum. You have to have some shielding for the gammas when they strike anything of heavy metal. With gamma rays the shielding is significant.

Representative VAN ZANDT. What do you use for shielding against the gamma rays?

Captain POMERANTZ. You have to use the same things that are associated with cobalt sources or reactors. We have to deal with heavy concrete or lead or something of that nature. Because of the 15 inches of penetration we have to deal with many feet.

Representative VAN ZANDT. That is the reason I put the question.

Captain POMERANTZ. With machines we just have to have a minimum amount, but you still have to have shielding because of scatter X-rays. They are relatively soft, and cannot penetrate as far.

The bactericidal action and the sensory changes seem to be of no significant difference between the electrons and gammas based on the research done to date. The bactericidal action is just as good from either one.

Technical personnel required; a few, 1 or 2 or 3 people, to operate an electron source. When we get into reactors, we have quite a few. With isotopic sources again we would not have to have quite as many.

I would like in closing to point out that steps are definitely being taken by the electron manufacturing industry today to increase the efficiency of their machines and to increase their power output and intensity. However, to make a cost evaluation today of gammas versus electrons, it is most difficult, because as I have already mentioned in answer to your question, the manufacturers today have built these tools primarily for research and development, and have not built them for cost and also for high-production efficiency rates.

Representative VAN ZANDT. Captain, Pomerantz, how many firms are involved in the production of these new machines?

Captain POMERANTZ. I will answer that by listing first the companies with whom we are working. They are General Electric Corp., X-Ray Division; the High Voltage Engineering Corp. of Cambridge, Mass.; the Electronized Chemical Corp., of Brooklyn, N. Y. We are in the final stages of negotiating a contract with the Applied Radiation Corp., of Walnut Creek, Calif. In addition, we have inquiries from Westinghouse Electric Co., Radio Corporation of America, and American Machine & Foundry. I believe that is the list as we know it today. I am quite certain there are other firms that are thinking of this, but have not visited us.

Representative VAN ZANDT. Are you satisfied that the activity in this field of industry is sufficient to meet the demand, should we reach that breakthrough?

Captain POMERANTZ. I will best answer that by one of the approaches used by one of the companies that visited us a week or two

ago. I would rather not specify the name. They mentioned to us that they felt that they had been sitting on the sidelines a little too long. They are not going to be sitting that way any longer. I think the more that appears in the press, and the more interest that develops at these open hearings and meetings, I feel more and more companies will soon be getting into this. Electronic devices are now universally used throughout the country and the electronic scientists can develop machines of that nature if they feel there is a demand.

Representative VAN ZANDT. Have you had any inquiries from manufacturers abroad?

Captain POMERANTZ. Just from one, a subsidiary of General Electric. That is the only one I can recall.

In summary, I would like to say that the ability to turn machines off and on with a mere flip of the switch appears to offer an advantage to this type of radiation, as does its relative ease of handling, its relative safety and its flexibility. Thus it would appear that for certain specific uses in the food industry, the electron generators will have their place. However, it is also apparent upon further evaluation that there will be many other specific uses within the food processing industry where the utility of the gamma rays certainly will not be surpassed by the electrons.

Representative PRICE. Could you give us a description of the Dugway Proving Ground facility for food irradiation? What do you have out there?

Captain POMERANTZ. I can give it to you briefly. Mr. Horner perhaps will discuss it in greater detail.

Representative PRICE. If Mr. Horner is going to discuss it, there would be no need of further description.

Representative VAN ZANDT. Captain, I notice in your statement you say that this provides sterilization capacities of 50 to 3,000 pounds per hour.

Captain POMERANTZ. That is right, if we get to the 12-kilowatt range.

Representative VAN ZANDT. Do I understand that while this is still in an experimental stage, we have the production capacity of approximately 3,000 pounds per hour?

Captain POMERANTZ. We would have if we used the largest unit we saw here.

Representative VAN ZANDT. What size unit do you have now?

Captain POMERANTZ. The largest one we are using today is a 2-million-volt unit with a one-half kilowatt power output and we are dealing very close to 50 to 100 pounds per hour.

Representative VAN ZANDT. Are you restricted to any particular kind of food, or are you generalizing on the food?

Captain POMERANTZ. We can use any kind of a food, but when we deal with electrons, unfortunately we have to keep it in that quarter-inch maximum penetrable layer. We have to take our steaks and shave them down to thicknesses not to exceed a quarter of an inch. I believe in front of you you have a picture of the Dugway facility. (Exhibit 12, p. 34.) That is a so-called radiation hot cell.

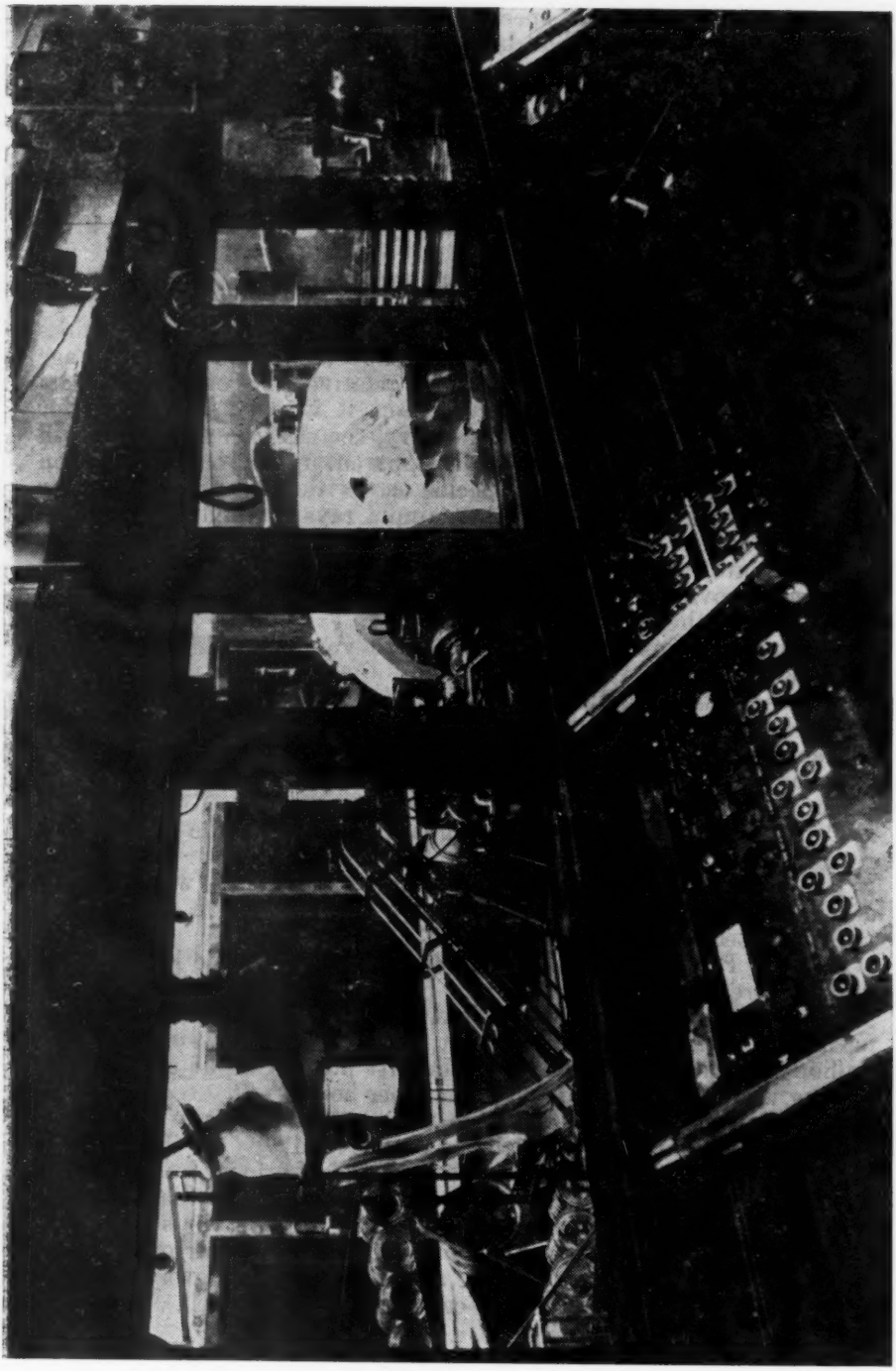


EXHIBIT 12.—Gamma radiation test facility, Dugway, Utah.

It has many feet of protecting material between the big casket or coffin you see inside. That weighs approximately 20,000 pounds. It is carefully insulated and refrigerated as well, because the heat of the eight fuel elements, and Mr. Horner will go into detail on that, without refrigeration, it makes the temperature within that chamber exceed 300° F. We, therefore, have to have considerable refrigeration to keep the temperature down. We have an automatic conveyor belt where we can take No. 2 cans and the larger size No. 10 can, and a continuous rotating device, and spin the cans through. They are running through approximately three No. 10 cans per hour. Each No. 10 can holds approximately 6 or 7 pounds of food. So we are getting an output of 20 pounds per hour. We can run that 24 hours per day. There are no mechanical changes that have to be made.

Representative VAN ZANDT. Does the food have to be at any particular temperature?

Captain POMERANTZ. We like to irradiate at the frozen stage, because it seems to give us the optimum product from the standpoint of flavor and color.

Representative VAN ZANDT. As I understand you, the food is first frozen and then irradiated?

Captain POMERANTZ. That is right. That does not have to be the case, and with certain dry products it is not necessary.

Representative PRICE. May we have the next witness?

General HERTFORD. The next witness is Mr. Charles R. Horner, of the Atomic Energy Commission

STATEMENT OF CHARLES R. HORNER, DIVISION OF REACTOR DEVELOPMENT, ACCOMPANIED BY ROBERT LOWENSTEIN, OFFICE OF THE GENERAL COUNSEL, UNITED STATES ATOMIC ENERGY COMMISSION

Mr. HORNER. Mr. Chairman and members of the subcommittee, I don't wish to be redundant, but since I am the only representative from the Atomic Energy Commission, I would like to present some background information.

In the operation of nuclear reactors highly radioactive fission products are produced. The unique character of this material has opened new capabilities for the atomic energy industry. Technical developments utilizing the radiations from these fission products have reached the stage where extensive applications appear possible. Their successful use would provide an economic outlet for radioactive waste material presently stored in underground tanks—a costly operation.

Five years ago the Atomic Energy Commission initiated research and development activities within its own laboratories and with universities to investigate and develop uses for fission products. The most promising use of this material at the present time is for food preservation.

Based on agreement between the Atomic Energy Commission and the Department of Defense, the Commission terminated in 1954 its support of food preservation work when the Army undertook its program. The Commission is still sponsoring work to promote economic uses for fission product material, but principally in the field of chemical

reaction promotion. To assist the Army and industry to carry out investigative studies, various types of gamma radiation sources are made available by the AEC.

I will not attempt to weigh the relative merits of the sources from an economic standpoint. At present there is not sufficient information available to arrive at sound conclusions. It is contemplated to conduct economic studies in order to determine this.

Characteristics of gamma radiation: Gamma rays can be produced by accelerators or the decaying atoms or radioisotopes. Only the latter source of gamma rays will be discussed.

Characteristics of fission product radiation: Radioactive isotopes such as cesium, strontium, krypton, and iodine, are formed by the fissioning of uranium. These isotopes are termed fission products, and they emit both beta and gamma radiation with varying intensities and energies. Their half-life, which is a measure of their rate of decay, varies from fractions of a second to hundreds of years. When fission products are in the gross form, i. e., unseparated, the radiation considered is only the gamma rays, since the beta rays are mostly trapped within the gross fission products and contribute only to thermal heating. It is possible, however, to separate certain isotopes from the gross products. This has been done for isotopes such as cesium, which is a long-life gamma emitter, and strontium, which is a long-life beta emitter.

Source of gamma radiation: The sources of gamma radiation which will be described are spent fuel assemblies, fission products materials, reactor produced isotopes and reactors.

Spent fuel assemblies: When spent fuel assemblies are removed from a reactor they are copious emitters of gamma rays. Beta rays are also emitted, but the majority of these rays are absorbed, thereby causing the fuel assembly to become thermally hot. In this form these assemblies are fission product sources which still contain unfissioned materials such as plutonium and uranium.

To be specific, consider a spent materials testing reactor fuel assembly.

I have one here which I should like to show you at this time. This is a mockup model. The plates within this assembly contain the uranium.

Representative HINSHAW. What type of core?

Mr. HORNER. That is a uranium alloy in the plate, sir.

When this assembly is taken from the reactor, it is kept in a pool or canal of water until it has decayed sufficiently to permit further chemical processing. At this time, it is then removed to the chemical processing plant where the special nuclear material is recovered. The residue, in a liquid state, is unconcentrated gross fission product waste containing other inert chemicals which were used to separate the plutonium and uranium. These wastes are then transferred to underground tanks for storage.

For the past 2 years these spent fuel assemblies have been used during the cooling period as high intensity sources of gamma radiation at the National Reactor Testing Station at Idaho Falls, Idaho. Radiation doses as high as 4 times 10 to the seventh rep per hour can be delivered by using combinations of the assemblies. This source decays quite rapidly in the first 20 days after removal from the reactor. However, its proximity to the materials testing reactor makes it

simple to maintain high levels of activity by frequent replacement with new assemblies. By June a new gamma irradiation facility will be ready for operation in an unclassified area at the National Reactor Testing Station. This facility will be available both to the Army and industry.

Representative HINSHAW. You have used the expression "rep per hour." I understand roentgen per hour, but what is rep?

Mr. HORNER. The rep is used by people who are working with irradiation of solids such as foods. A rep is a radiation dosage unit equal to the absorption of 93 ergs per gram. It is an energy unit that indicates the amount of radiation that the product has received. For all these purposes a rep and a roentgen are identical.

Representative HINSHAW. We understand a little bit about what a roentgen is, but when you spring rep on us, we cannot tell.

Mr. HORNER. That stands for roentgen equivalent physical.

Representative HINSHAW. In other words, you have 40 million of them; is that right?

Mr. HORNER. That is right, sir, per hour.

Representative HINSHAW. Forty million roentgens per hour.

Mr. HORNER. That is right. That is the rate the dose is delivered from a combination of these assemblies.

Representative HINSHAW. That is quite a few.

Mr. HORNER. Yes, sir.

Representative HINSHAW. It is quite lethal.

Mr. HORNER. It is very lethal.

Representative HINSHAW. Very well; you may proceed.

Mr. HORNER. In October 1954, the AEC granted a license to the Department of Defense to possess eight spent MTR fuel assemblies for use by the Quartermaster in its food sterilization studies at Dugway, Utah. To maintain the level of radiation desired, it will be necessary to replace these elements about every 6 months.

Another new gamma irradiation facility is under construction at the Argonne National Laboratory in Chicago. This facility will also utilize spent MTR fuel assemblies, but will not be as intense as the Idaho source. It will serve the Army, its contractors and industry in that area. Present progress indicates that it will be ready for use by early summer.

The Commission is presently exploring the possibility of using as radiation sources other spent fuel assemblies from reactor projects other than MTR.

Fission product wastes: As previously stated, considerable amounts of radioactive wastes are in storage tanks and the daily operation of both AEC and industrial reactors will constantly increase this volume of wastes. Techniques for concentrating and packaging these wastes are currently under development. A separation plant is now being constructed at Oak Ridge National Laboratory to separate from the fission product wastes the 33-year half-life gamma emitter, cesium. This plant should be in operation by September 1956, and separating cesium at the rate of 200,000 curies per year.

Reactor-produced isotopes: A large part of the research and development work which has been done to date has used radioactive cobalt sources produced in nuclear reactors. Cobalt emits 1.1 and 1.2 Mev gamma rays with a half-life of 5.3 years. In general, we believe that the use of reactor neutrons to produce isotopes like cobalt for food

sterilization is useful for research work where small quantities of materials are irradiated. However, for processing large quantities such as on a commercial basis, this is likely to be quite expensive.

Reactors: Limited studies indicate that reactors might prove to be technically and economically feasible as sources of gamma radiations.

For example, it has been suggested that (1) an external fuel circuit of a fluid fuel reactor be used as a source; (2) certain material might be circulated in a loop through or near the reactor core to become activated by the neutrons and thus produce gamma radiation; and (3) that the short half-lived fission product gases be extracted from the reactor core and used as a source of gamma rays.

Concepts like these could provide sources by modifying existing reactors or including such arrangements in planned industrial power and research reactors. As presented, these reactor sources of gamma radiations propose modifying reactors that have other primary functions such as for power or research. It may prove feasible to construct a reactor that would be used solely or primarily for food sterilization. However, such a single-purpose reactor would not utilize 90 percent of the fission energy which is produced as heat. The Commission intends to assist the Army in evaluating these concepts.

Dosimetry: When irradiating food, care must be taken to assure that the product has received the proper amount of gamma radiation. Therefore, a dosimeter, which is a device for measuring gamma radiation, is placed in or next to the product. The Commission is assisting the Army by evaluating materials which appear useful for this application. At present, one of the most promising materials is a phosphate glass. Such work is being carried on under Commission sponsorship at the Naval Research Laboratory and the Massachusetts Institute of Technology.

I have here on a card a series of these glasses which you can view. This particular glass is an adaptation of a glass that was originally used by the Armed Forces for personnel dosimetry.

Representative VAN ZANDT. I am very much interested in that last paragraph, especially where you say with irradiating food, care must be taken to insure that the product has received a proper amount of gamma irradiation. Can you give us a further explanation?

Mr. HORNER. For example, we know that a certain dose will sterilize the food properly, and if you exceed this, you might get into the difficulties of side effects. I think this particular question might be elaborated on by Dr. Kraybill of the Army Medical Nutrition Laboratory.

Representative VAN ZANDT. Will that information be furnished by another witness?

Mr. HORNER. Yes.

Representative VAN ZANDT. I am thinking now about the consumption of the food.

Mr. HORNER. Toxicity and the like? That will be discussed later.

Representative VAN ZANDT. Thank you.

Representative PRICE. In your statement you mentioned the radioactive sources. What source do you think will have the best commercial possibilities?

Mr. HORNER. My feeling at the moment in looking over the entire picture is that it will all depend on what you are doing, where you are

doing it, and when. I don't think out of all these sources you are going to pick one source and say this is it.

Representative PRICE. You say it is feasible to construct a reactor to be used solely for food sterilization. What about a dual-process reactor for power and food sterilization?

Mr. HORNER. Yes, that would be a most sensible way. Maybe you could do it economically with the price of uranium, however, you would be putting 90 percent of the heat down the drain unless it were a power-type ractor.

Representative PRICE. Do you think an idea such as that might make a power reactor, like the one the Duquesne Co. is now in process of constructing, a more profitable operation?

Mr. HORNER. Every reactor has radioactive waste. If they can get some return for this waste, it will knock down the cost of the kilowatt.

Representative PRICE. You think the same kind of reactor that Duquesne is building in the power program now could possibly be used in the food-sterilization plan?

Mr. HORNER. I think I could say at this moment that the spent fuel elements could be used directly.

Representative VAN ZANDT. The Pennsylvania State University is building a swimming-pool type reactor.

Mr. HORNER. Yes, sir. This particular fuel element is the type used in those types of reactors.

Representative VAN ZANDT. In other words, food sterilization could be included in the experimental work of the university when it has in operation its swimming-pool type reactor?

Mr. HORNER. Yes. They can modify that reactor if they so desire.

Representative PRICE. Mr. Horner, will all the radiation facilities for the food-sterilization program be unclassified?

Mr. HORNER. Yes, we are working to that end.

Representative PRICE. Will there be any classified information in connection with the program?

Mr. HORNER. A small amount.

Representative PRICE. In what area would that lie, if there is any.

Mr. HORNER. Possibly when you start numbering the amount of waste and sources which you have that relate to the production program.

Representative PRICE. Would any type of license be required by a food manufacturer who planned to use fission products for radiation?

Mr. HORNER. I would like to ask Mr. Robert Lowenstein of the General Counsel's Office of the Atomic Energy Commission to answer that question.

Mr. LOWENSTEIN. As I understand it, in fission products there would generally be both special nuclear material and the radioactive materials defined in the Atomic Energy Act of 1954 as byproduct material. Licenses are required under the act to possess and use both types of materials. A private manufacturer who wanted to obtain such material could submit a single application to the Commission requesting authority to possess both the special nuclear material and the byproduct material. We would review his application from the standpoint of determining whether he has the skills and experience to enable him to possess and use the material in such a way as properly to protect his employees and the public, and we would

be interested in knowing also what his equipment and facilities are for the protection of his employees and the public. When we had reviewed these, we would then issue him a license to obtain the materials if his application is acceptable.

Representative VAN ZANDT. Then the most important requirement is the safety factor.

Mr. LOWENSTEIN. We are principally interested in this part of the program in health and safety, that is, protection from the radiation which is emitted by these very highly radioactive materials.

Representative PRICE. Mr. Horner, does the Commission foresee any possibility of using any of the products from Hanford or Savannah River in the radiation sterilization of foods?

Mr. HORNER. Yes, sir. As a matter of fact, we are presently carrying on a survey of all of these, to find out what we have available now and in the future.

Representative PRICE. How long will it be before that survey is completed?

Mr. HORNER. I would hope in a matter of not too many weeks.

Representative PRICE. What are the Commission's thoughts concerning payments for the use of fission products?

Mr. HORNER. We haven't worked out any pricing schedule. The guidance would come from the radioisotope pricing policy. At the moment I cannot give you any numbers which would relate curies to dollars.

Representative PRICE. I think you made a statement at the beginning of your remarks to the effect that the Commission had practically placed full responsibility for the food-sterilization program with the Defense Establishment.

Mr. HORNER. That is right, sir.

Representative PRICE. Is the Commission contributing financially to the program?

Mr. HORNER. The Commission offers assistance in the form of facilities, materials, and technical know-how. For example, we have built a better facility at Idaho and a new facility at Argonne.

Representative PRICE. The Commission built these facilities.

Mr. HORNER. That is correct. We are concentrating on sources of radiation.

Representative PRICE. Does that complete your statement, Mr. Horner.

Mr. HORNER. Yes, sir.

Representative PRICE. General Hertford.

General HERTFORD. Next we have Dr. H. F. Kraybill, Army Medical Nutrition Laboratory, Denver, Colo., who will talk about the wholesomeness of irradiated foods.

STATEMENT OF DR. H. F. KRAYBILL, ARMY MEDICAL NUTRITION LABORATORY, DENVER, COLO.

Dr. KRAYBILL. Mr. Chairman and committee members, ladies and gentlemen, the areas of research to be discussed by me are the testing of the toxicity and nutritive quality of foods that have been irradiated.

In 1948 studies were initiated in the Army Medical Nutrition Laboratory relating to the nutritional aspects of feeding irradiated rations to test animals. In these experiments conducted with rats certain

observations suggested some destruction of vitamins. However, it is well known that other forms of food processing currently used also destroy vitamins. Subsequent experimental work at Swift & Co. Research Laboratories (Chicago, Ill.), the University of Michigan, and Columbia University indicated no gross toxicity but similar findings with regard to vitamin loss.

In the following table we have summarized some of the institutions that have been concerned with the toxicity testing program. Starting in 1948, the laboratory basal ration was tested on rats. Swift & Co. did some work testing raw ground beef. Columbia University did some work with milk products. The University of Michigan tested a canned ground beef, and at the present time the Surgeon General is testing 50 typical irradiated foods in various test species.

Historical development—Toxicity studies of irradiated foods

Institution	Year started	Types of irradiated food
1. Medical Nutrition Laboratory	March 1948	Laboratory basal ration.
2. Swift & Co	September 1950	Raw ground beef.
3. Columbia University	May 1952	Milk products.
4. University of Michigan	March 1953	Canned ground beef.
5. Surgeon General's program	March 1954	50 representative foods.

From these results it was believed that if there was any radiation-induced toxicity, it was of an obscure nature. The Army's program for evaluating foods sterilized by irradiation consists of two main parts, namely (1) tests for radiation induced toxicity which might be of an obscure nature and (2) tests of nutritive value and wholesomeness of foods.

In this program, the methods endorsed by the Food and Drug Administration, the United States Department of Agriculture, and private testing laboratories were used for testing of irradiated foods.

Induced toxicity. In an evaluation of toxicity the test should reveal the presence of any agent which when introduced, especially in small amounts, into an organism may chemically produce an injurious or deadly effect. In order to detect such substances, the toxicity studies are divided into short-term feeding experiments, commonly referred to as subacute toxicity tests, and long-term feeding experiments known as chronic toxicity tests. The short-term studies are usually conducted for an 8-week period, while the long-term feeding studies are continued for 2 years or are carried through 4 successive generations of rats, or any other test animal.

In the short-term feeding study the objective is to furnish a nutritionally adequate diet for the animal while simultaneously providing a large amount of irradiated food in the diet in testing for toxicity. This can be accomplished by feeding a mixture of 65 percent unirradiated basal diet containing all the known nutrients plus 35 percent by dry weight of the irradiated food to be tested. Vitamin supplements are provided to insure against deficiencies due to lack of such nutrients. Upon completion of the short-term feeding, experimental data are compared with regard to food consumption and growth (body weight change) for the animals on the unirradiated and irradiated food diets. Any diminution in growth rate and any

apparent abnormalities in the animals are investigated by histopathological examination of the tissues of such animals.

In the long-term feeding experiments data are recorded on growth, and food consumption and observations are made with reference to reproduction, lactation, size of litters, viability of the young, and longevity. Any gross abnormalities noted are followed by the usual histopathological examination of the animal's tissues. In similar long-term experiments observations are made as to the effects of feeding irradiated foods or painting the extracts of such foods on the skin of the test animal in order to detect the possible presence of radiation-induced cancer-causing substances.

Nutritive quality: Since nutrients such as the vitamins, fats, carbohydrates, and proteins may undergo changes during irradiation, it is important to study these changes by animal-feeding experiments. The commonly used indices for measurement of nutritional quality are growth, reproduction, lactation, biological value of protein (utilization of protein), metabolized energy (energy derived from total energy supplied in food), longevity, and the concentration of enzymes in the tissues of the animal subsisting on either non-irradiated or irradiated foods. These biological indices reflect the ability of the food in question to sustain the animal's vital processes.

Contractual research program: The broad contractual research program on wholesomeness involving the collaboration of 12 universities, encompasses studies relating to toxicity and nutritive value of irradiated foods.

In the following table we have summarized some of the areas of research that are conducted by 12 of the leading universities where we have some of the eminent nutritionists in this country. There are studies concerned with vitamins, using rats and chickens.

List of Surgeon General's contractors and areas of research

Contractor	Areas of research (all feeding experiments)
1. Alabama Polytechnic Institute	Vitamin studies and longevity (rats and chickens).
2. University of Illinois	Metabolizable energy, biological value of protein.
3. University of Colorado Medical Nutrition laboratory.	Subacute and chronic toxicity, human feeding.
4. Columbia University	Vitamin E and fatty acids.
5. Oregon State College	Reproduction, growth, subacute and chronic toxicity.
6. University of California	Fats and fatty acids.
7. Texas A. & M. College	Longevity, reproduction (rats and chickens).
8. Cornell University	Growth, reproduction, lactation (dogs).
9. University of Michigan	Growth, reproduction, egg production (chickens).
10. University of Rochester	Digestibility studies (dogs).
11. Wisconsin Alumni Research Foundation	Carcinogenicity (rats and mice) subacute toxicity.
12. Armour Research Foundation	Subacute toxicity testing.

In the next table we have summarized the areas of research that are covered by the Surgeon General's contractual program using various test species. For example, in the case of toxicity we have the short-term feeding, the long-term feeding, and the carcinogenesity studies. In this we have used the rat, mouse, chicken, dog, monkey, and the final test will be with man.

Areas of research covered by Surgeon General's contractual program

	Rat	Mouse	Chicken	Dog	Monkey	Man
TOXICITY						
1. Short-term feeding	√	√	√			√
2. Long-term feeding	√	√	√	√	√	√
3. Carcinogenicity	√	√				
NUTRITIVE QUALITY [1]						
1. Growth	√	√	√	√	√	√
2. Reproduction	√		√	√		
3. Lactation	√			√		
4. Tissue enzymes	√		√			
5. Metabolizable energy	√					√
6. Longevity	√	√	√	√	√	
7. Biological value of proteins	√					

[1] Alterations in vitamins, fats, CHO, and proteins will be reflected in observed responses.

As to nutritive quality, we look for the effect on growth, reproduction, lactation, tissue enzymes, metabolizable energy, longevity and the biological value of the proteins.

If there is any alteration in the vitamins or the fats, carbohydrates or proteins, you will get an observed effect in these factors.

The comprehensive feeding studies are designed to include the testing of irradiated foods on a broad spectrum of test species, including mouse, rat, chicken, dog, monkey, and finally man. All indexes and factors previously described in the short-term and long-term feeding experiments are included in this program.

With such an extensive program of research covering all phases of the problem, our knowledge concerning the wholesomeness of irradiated foods will be greatly enhanced. Some of the most prominent investigators in the field of nutrition are participating in this program. While it is perhaps too early to make complete evaluation on the nutritive value and physiological effects of irradiated foods, data collected thus far would suggest no toxicity of irradiated foods from short-term feeding experiments.

In this next table we have some typical irradiated foods listed, haddock, bacon, peaches, and fresh ham. They were incorporated into a diet as we indicated earlier at a level of 35 percent dry weight and fed to the test animal, the rat. These are figures on the daily food consumption in grams dry weight.

Daily food consumption in grams dry weight (short-term feeding experiments)

Food	Irradiation level		
	3×10^6 Rep	6×10^6 Rep	Unirradiated control
Haddock	12.8	12.1	12.3
Bacon	11.5	10.9	10.6
Peaches	15.3	15.6	16.7
Fresh ham	13.0	13.3	12.6

NOTE.—Weanling rats, 10 per group; diet, 35 percent dry weight irradiated food; duration, 8 weeks.

The food was irradiated in Idaho at 3 million rep and 6 million rep, and the food consumption data for animals on either one of these radiation dosage levels was compared with rats that were maintained on an untreated diet. You will see by inspection that the food consumption figures are quite comparable, there being no significant difference in the food consumption of rats maintained either on a treated or nontreated diet.

The next chart (exhibit 13, below) is merely an amplification of the previous table wherein we show the growth rate of rats on two typical radiated foods, haddock and bacon. Here the food was radiated to 3 times 10 to the sixth rep and 6 times 10 to the sixth rep, and the comparison was made between the controls and experimental groups.

GROWTH RATE OF RATS ON DIETS CONTAINING IRRADIATED FOODS

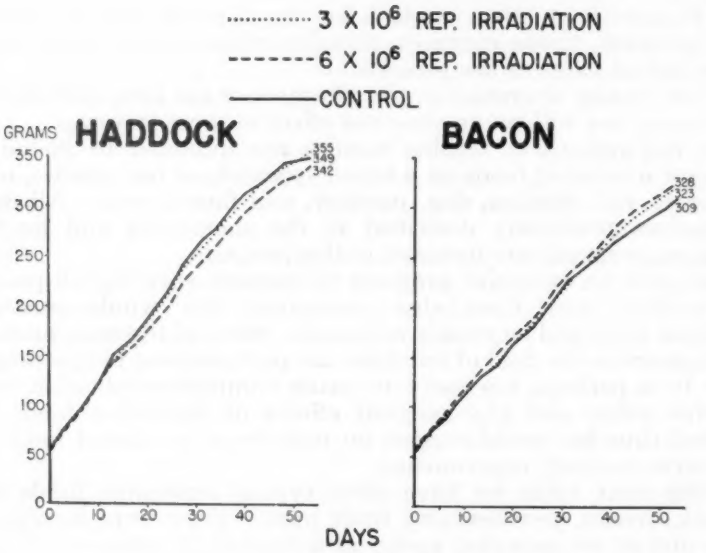


EXHIBIT 13

The heavy line represents the growth rate of rats maintained on unirradiated food and the dotted line represents the growth rate for rats that were maintained on a diet in which 35 percent by dry weight consisted of irradiated foods. You can see that the lines parallel one another and converge at some places, and the data on the growth rate of these rats analyzed statistically would indicate no significant difference in the two groups.

Today is particularly significant in that nine humans will be placed on a diet of irradiated foods commencing this morning at the Medical Nutrition Laboratory, Denver, Colo. This group of volunteers, members of the Mennonite Church of the Rocky Mountain area, secured through the cooperation of the local and national selective service system, who have cooperated in this investigation. In preparation for the initiation of the human volunteer feeding program,

background medical investigations on the group have been conducted since November of last year. Volunteers will be given 2 to 3 months' diet on a given radiated food which has been previously cleared by toxicity studies on animals. The best of dieticians and nurses, and I might add, medical officers, will be present to insure that experiments are carried out in the most effective way and that the health of the volunteers is continually considered.

Only through such a comprehensive toxicity screening program as previously described, can the health of the consumer of this food be properly safeguarded.

The Food and Drug Administration is apprised of the results of these investigations through progress reports as they become available.

Representative PRICE. Dr. Kraybill, I wonder if you could tell us what the diet of these nine men will be?

Dr. KRAYBILL. Yes, sir. This diet will consist of 13 foods. There are actually 12 irradiated foods that will be fed to these men. The diet will contain, on the basis of calories, 35 percent irradiated food. The rest will be unirradiated food, such as lettuce and certain vegetables that have not been treated.

Representative PRICE. Will it all be irradiated food, or will they have other food?

Dr. KRAYBILL. No, they will have other foods added. Only 35 percent of the total calories of the diet will be irradiated food; 65 percent will be unirradiated. That is, 65 percent of the calories.

Representative PRICE. Why not all irradiated food?

Dr. KRAYBILL. We do not know that much about acceptance or palatability. There might be a matter of palatability so that if we attempt to give 100 percent irradiated diet, we might end up the first day with very low consumption. As we indicated on the charts we can get not only acceptability data, but also possible toxicity data from feeding human test subjects a diet at a level of 35 percent.

Representative PRICE. What kind of tests will you make on these men during that period?

Dr. KRAYBILL. The general observations will be made as to acceptability. They will have a chart that they fill out and tell something about the texture, the flavor, the color and odor of the food. Fecal samples will be taken. Urine samples will be taken for analysis. Digestibility studies will be run. Metabolizable studies will be conducted. That is, the feces and urine from these test subjects will be analyzed. We will do protein analysis on the feces and urine. We will have two groups. One group will be maintained on a diet of unirradiated foods and one will be subsisting on irradiated. We will be able to get comparisons between the two groups.

Representative PRICE. You say it will be about a 2 or 3 months' test?

Dr. KRAYBILL. Yes, with the present group. I should qualify that statement to indicate that 3 months is the entire experimental period. Actually the men will be maintained on the diet for about 3 weeks and then they will get a rest for a week or 2 weeks before they start on the next diet.

Representative HINSHAW. Is there something particularly suitable about the Mennonite group that they should have been selected?

Dr. KRAYBILL. They seem to lend themselves to this kind of experiment. They are very cooperative. They entered into this thing

wholeheartedly. We approached Bishop Yost who is with the Mennonite Church in Denver. First we approached the Selective Service and they referred us to Bishop Yost. We had 1 or 2 meetings with the Mennonite Central Committee of Pennsylvania, and they discussed the matter of getting human volunteers. They are also using human volunteers at the National Institute of Health who are Mennonites. We have had offers from other religious groups. We have had communications from Europe, especially Germany and France.

Representative HINSHAW. Do these people get any particular credit with Selective Service? I believe most of them are conscientious objectors.

Dr. KRAYBILL. They are. They can serve in a hospital for 2 years doing war work or they can come to us for a laboratory experiment for a year. If they serve with us for a period of 1 year, their time of duty of 2 years may be shortened somewhat. That is at the discretion of Selective Service, and also in cooperation with the Mennonite Church.

Representative PRICE. The committee will stand adjourned until 2:30 this afternoon. We have a quorum call in the House. Otherwise we would go straight through here.

(Thereupon at 12:25 p. m., a recess was taken until 2:30 p. m., the same day.)

AFTERNOON SESSION

Representative PRICE. The committee will be in order.

General Hertford, are you ready with your next witness?

General HERTFORD. The next witness is Dr. Ralph G. H. Siu, Technical Director of the Research and Development Division, Office of the Quartermaster General, who will talk on the qualitative aspects of radiated foods.

STATEMENT OF DR. RALPH G. H. SIU, TECHNICAL DIRECTOR, RESEARCH AND DEVELOPMENT DIVISION, OFFICE OF THE QUARTERMASTER GENERAL

Dr. SIU. Mr. Chairman, members of the committee, and ladies and gentlemen, after the interesting talks this morning, the question naturally comes down to, Where do we stand now? What foods can be irradiated and acceptable, and what foods cannot, and why not? These questions border on the current state of the art which I would like to cover in the next 10 minutes.

Before we get into a delineation of foods, perhaps we should say a few words about the type of chemical reactions that occur in irradiated foods. First a word or two about enzymes.

Enzymes are chemicals that are found in living tissues that bring about changes. There are lots of these enzymes in fresh foods, fresh meats, fresh vegetables. Some are good, like the ones that bring about the tenderizing of meat. Some are not too good, like the ones that bring about the rancidity of certain fats. Unfortunately for us these enzymes are not very susceptible to radiation. In the case of bacteria, if you have about 2 million units, the bacteria will be killed. But in the case of some of the enzymes even at 20 million, they will not be inactivated. So that is one problem facing us.

Fortunately for us, though, many foods do not have much of the harmful type of enzymes. In the case of other foods we can inactivate the enzymes by combination with some other treatment, such as a mild heat treatment or blanching.

The second group of reactions in which we are interested concerns off-flavor and off-odors. When we look at the radiation process, we note that the rays disrupt the protoplasm of the bacteria and damage the cell thus bringing about death. Since the rays cause this extensive amount of damage to the bacteria, we would expect that it would do something to the food tissues themselves. That is what happens. There is frequently a generation of off-odors, off-flavors, especially when you get into the high doses above a million units.

The problem, then, is how can we kill the bacteria and still not bring about these off-odors and off-flavors or a breakdown in the tissue structure of the nice crispy vegetables. We are currently studying the problem. There are some clues.

For example, if you radiate in the frozen state, you can minimize the amount of off-odors. If you radiate in the absence of oxygen, you can also control the amount of off-odors. If you radiate in the presence of some inhibitors, like ascorbic acid, you similarly diminish the amount of off-flavors and off-odors.

With that background, then, let us turn to the foods themselves. The first question is, what is the present state of knowledge concerning foods that we irradiate, which we would want to keep in storage without refrigeration?

This table shows a listing of these foods. This is a present estimate of promise for storage of perishables without refrigeration. The dose is about 2 million reps.

Present estimates of promise—storage of perishables without refrigeration

[Dose: 2,000,000 reps]

GOOD	FAIR	POOR
Asparagus	Applejuice	Banana
Bacon	Applesauce	Beans, lima
Beans, green	Beefsteak	Cantaloup
Beef liver	Bread	Celery
Broccoli	Cabbage	Cheese
Brussel sprouts	Cherries	Frankfurters
Carrot	Corn	Lemon juice
Chicken	Halibut	Lettuce
Codfish cakes	Ham	Milk
Pork	Hamburger	Oranges
Pork sausage	Lamb chops	Orange juice
Waffles	Peas	Squash
	Spinach	Strawberry
		Sirup
		Tomato juice

We have listed in the first column those foods which in the light of our present knowledge show good promise without too much further work. Those foods that show fair promise and those foods that show poor promise at present are listed in the second and third columns respectively. So the idea of the behind part of our research is to solve the reasons why these latter foods are as bad as they are and to push them over into the good column.

In the "good" column, we have asparagus. There is a conflicting opinion on this. Some people claim that there is a bleaching of

asparagus while other people claim that the amount of damage is low. To be more accurate, asparagus should be in the "fair" column. Bacon, beans, beef liver, broccoli, brussels sprouts, carrots, chicken, codfish cakes, pork, pork sausage, and waffles are the others in the "good" column. In these the flavor changes are minimal. These foods look pretty good at the present state of the art.

In the case of the "fair" column, let us discuss beefsteak in which we are all interested. There is a slight change in flavor and odor of irradiated beefsteak. There is apparently a conflict of opinion from different laboratories. Some laboratories claim they cannot tell the difference between an irradiated beefsteak and an unirradiated beefsteak. Other laboratories claim you can tell the difference, but you would just as soon eat one as the other. Still other laboratories claim that the odor is distinctly undesirable. Perhaps some of the difference of opinion is due to the fact that not everybody is equally familiar with the art of panel taste testing and irradiation at the present time.

Let us go to the "poor" column. We have bananas, lima beans, cheese, and milk. You were particularly interested in that latter, Mr. Van Zandt. That product does not respond very well. Its odor is not too good after irradiation. As far as the difficulty of the research problem is concerned, it represents one of our most difficult flavor problems.

How can we offset the bad odor from the irradiation of dairy products? Apropos of your question about Pennsylvania, Mr. Van Zandt, we just activated a contract at Penn State University with the dairy expert there, Dr. Patton, who will be working on this very problem. Why is it that milk and dairy products give off such a bad odor and flavor? We hope with that very capable institution that the problem will be solved.

Representative VAN ZANDT. Does that also apply to powdered milk?

Dr. SIU. Not as bad as the fresh milk. One difficulty is that the fresh milk has such a bland odor that when you generate off-odor, you notice it very much. With powder milk the amount of off-odor will not be as high, but it will be detectable.

Representative HINSHAW. Pennsylvania is not the only State that is interested. I see that oranges and orange juice are in that last column.

Dr. SIU. Yes, sir; orange juice is not too good; if we give it 2 million reps, that is. However, there was an advantageous finding in the irradiation of oranges, as we will come to later. You inhibit the formation of bitterness in the subsequently squeezed juice on standing. In the nonirradiated orange, the juice turns bitter in some varieties upon standing for over an hour or day.

Before I mislead the group, I must state that this finding is quite preliminary, sir, and we are not absolutely sure of it. The University of Michigan made the finding incidental to their other extensive work. They observed that when you irradiate the orange ahead of time and squeeze the juice subsequently, such bitterness will not occur on standing.

Representative VAN ZANDT. Doctor, I notice you have pork sausage under the "good" lineup and over here you have frankfurters under the "poor" lineup.

Dr. SIU. Yes, sir. I think this is a pessimistic view of frankfurters. If we are fairer, it should be at least in this "fair" column.

Representative PRICE. Dr. Siu, you don't have any pineapples in there. You ought to be representing your industry. The chamber of commerce from California and Pennsylvania have just been heard from. I understand you are from Hawaii. You should promote pineapples in here.

Dr. SIU. Yes, sir; I wish I could. I think the delicious fresh pineapple, if preserved, may well provide stiff competition to some of the other fruits on the market. Pineapples have not been irradiated so far. If the limiting factor in storage is due to microbial growth, on the skin particularly, the irradiation can be of help. This should be tried.

That represents the current state of knowledge with regard to the storage of perishables without refrigeration. We know that these foods in the "poor" column are bad with that high a dose. What if we give it a lower dose so the flavor change will not be so bad?

Representative VAN ZANDT. Before you go to the next chart, what is the duration of the preservation now?

Dr. SIU. As far as keeping it from the bacterial spoilage is concerned, you will never have contamination by bacteria. But you have the breakdown by some of the other factors like the enzymes. Offhand it varies from item to item. I would say it is in the order of months now.

As we said, if we give foods a lower dose of 100,000 to 500,000 reps, we can extend the shelf life of these items in refrigeration. Let us take cole slaw, hamburger, ham, scallops, salami, tomatoes, and sausage. Ordinarily they will last a small number of days. If you give it a mild treatment, it will extend the refrigeration shelf life up to five to ten times its normal expectancy.

EXTENSION OF REFRIGERATED SHELF LIFE

[Dose: 100,000 to 500,000 reps]

Beefsteaks	Ham	Sausage
Cabbage	Hamburger	Salami
Cherries	Lamb	Scallops
Coleslaw	Luncheon meat	Tomatoes
Fish	Peaches	

Representative PRICE. You are talking about refrigeration and not freezing.

Dr. SIU. That is right, sir. This is to extend the shelf life.

Besides these two uses of storage, we have still other possibilities of the application of radiation to foods. These are the nonsterilizing radiation applications on food. You notice the dose is still lower, 10,000 to 50,000 reps. The first application that we would like to talk about is the destruction of parasites. About 6 percent of the pork that is obtained from pigs which are fed fresh uncooked garbage have trichina parasites. Radiation destroys the trichina worms and gets rid of trichinosis.

NONSTERILIZING RADIATION APPLICATIONS ON FOOD

[Dose: 10,000 to 50,000 reps]

1. Destruction of parasites.
2. Destruction of insects.
3. Increased storage life of tubers.
4. Inhibition of sugar formation in tubers.
5. Suppression of bitterness in orange juice.

The second is the destruction of insects in foods, such as flour and grain. Even at low dosages the insects are destroyed very readily.

The third is the increased storage life of tubers. Last year your committee was informed by Dr. Butts of this particular use. The last two uses listed in the chart are preliminary findings by the University of Michigan and other laboratories. The inhibition of sugar formation in tubers is an interesting case. It is highly desirable to have a certain optimum concentration of sugar in potatoes in the making of potato chips. As a result the potato chip manufacturers are very much interested in the content of sugar in potatoes. When you store tubers at about 50 degrees fahrenheit, there is a high formation of sugar. Interestingly enough, potatoes that have been subjected to radiation do not develop this high concentration of sugar. That was quite a serendipitous observation incident to the main work on the inhibition of sprouting of tubers.

The fifth one, the suppression of bitterness in orange juice, we had discussed a little while ago.

Parenthetically I would like to mention here that when we talk about the destruction of parasites, insects and bacteria by irradiation we should recognize that the process can be applied to other items and commodities. We happen to be talking about food. We can just as well destroy insects in clothes, for example cloth moths in prewrapped overcoats before you store them away for the summer.

Representative PRICE. This can then be applied to shoes and clothing?

Dr. SIU. Yes, just as readily. You can kill any living thing in a pre-wrapped item, whether it be paper, shoes, leather, cloth or anything else.

Representative PRICE. General, that is an important military application, is it not?

General HERTFORD. Yes.

Representative PRICE. Could you give us some example of what that would mean to the military?

General HERTFORD. I think Dr. Siu can tell us more about the fungicide on leather and whether this would apply to fungus on leather.

Dr. SIU. Yes.

Representative PRICE. What would this mean to the military?

Dr. SIU. If you are interested in storing items without mildewing, and in a pre-wrapped item like a shoe, you can subject it to radiation and keep it without mildewing for as long as you want, as long as the package is not punctured. This will mean a large saving to the military. Normally in a tropical warehouse, you would have to go down every several weeks and wipe off the mildew with a piece of cloth. Right now we have solved that more or less with the use of fungicides. We do impregnate our combat boots with fungicides, and it does prevent the mildewing. However, radiation would be another approach to the problem. It is a matter of economics as to which is preferable.

The killing of clothes moths and carpet beetles in the storage of wool items is also quite a problem. Radiation would be applicable here too. We have not calculated the dollars and cents in this case, and we are sorry we cannot give it to you.

Representative VAN ZANDT. Doctor, you speak of the destruction of insects, and I am thinking now of insects in flour, beans and so forth. Does that mean permanent destruction of the insects?

Dr. SIU. If you can keep the item packaged well so the insects do not break through the package again, that would be permanent. In other words, everything within it will be killed.

Representative VAN ZANDT. I am thinking about handling dry beans in large burlap bags as they are handled in the military service. Your application of radiation in such a case would not be effective.

Dr. SIU. In burlap bags it would probably be recontaminated if you have it in an area which has a lot of insects. However, if you have another type of bag which is not penetrated by insects, then it should hold.

Representative VAN ZANDT. Could we go back to butter again?

Dr. SIU. Yes, sir.

Representative VAN ZANDT. My experience in the military service with butter has not been too good, because we actually threw tons of it overboard because it thawed on us and we could not freeze it again. Is this radiation going to help us solve the problem of handling butter?

Dr. SIU. The melting point is not affected by the radiation. In other words, you would still have a problem of the butter thawing as you described. It melts and turns rancid from the atmospheric oxidation. Radiation will not help. However, through other devices, you can develop a higher melting butter spread, which will not thaw. But radiation is not the way to solve that particular problem.

Representative VAN ZANDT. Is it in another field?

Dr. SIU. That is right, sir.

Representative PRICE. Dr. Siu, while you are on the subject of destruction of insects, in the handling of flour in normal commercial use, that would be a very great finding as it now causes considerable difficulty because of the infestation in the purest of flour. Would this irradiation help to control that situation?

Dr. SIU. I believe so, sir, the tiny eggs in the flour are very hard to sift out. Radiation will destroy them, sir.

Representative HINSHAW. How long does it take to give this treatment of 10,000 to 50,000 reps?

Dr. SIU. A fraction of a second, sir.

Representative HINSHAW. Then you could do it on a conveyor belt.

Dr. SIU. Yes, sir, a fraction of a second. A second underneath the belt would be all that is necessary, depending on the power of your source, of course. This is only about a hundredth of the dose for sterilizing. Captain Pomerantz told you that the pilot-plant generators available today will sterilize up to 3,000 pounds of material an hour. So even with the current machines you have enough power to go through tons of material for insect deinfestation per hour.

Representative HINSHAW. With respect to hams, the people who cure hams get a maggot they call a skipper. Would this take care of those things?

Dr. SIU. This would be very, very good.

Representative VAN ZANDT. In connection with the handling of pork, before you give it the dose of radiation, is it required that it be frozen?

Dr. SIU. For trichina? No, sir, no necessity. That is a very low dose so you don't have to worry about flavor changes.

Representative VAN ZANDT. What about the other program?

Dr. SIU. The other one, sir? I think the promise is pretty good so that the chances are you will not have to freeze pork for sterilization purposes either. There is some slight change but I don't think it is significant enough at the moment. If it is frozen, you may suppress the flavor change that much more, but I think pork is one of the meats in which we may not have to invoke ancillary aids.

Representative PRICE. Doctor, have you ever tasted any of this pork?

Dr. SIU. Yes, sir. But I am a very bad taster. I was not able to tell the difference between irradiated hamburger and nonirradiated hamburger, for example.

Representative PRICE. How would a piece of rare pork taste?

Dr. SIU. I have never tried rare pork in my life.

Representative HINSHAW. I never heard of anybody who did.

Representative PRICE. I have not, either, but it might be interesting.

Representative HINSHAW. I don't see potatoes anywhere on that list. Is that an intentional omission of an item?

Dr. SIU. No; inadvertent. I think a potato is a very good item as far as inhibition of sprouting is concerned. There is no flavor change of any sort. You can use it now if economically sound and toxicity cleared.

Representative HINSHAW. There was some attempt to extend the nonsprouting life of a potato that we heard about in the hearings a couple of years ago.

Dr. SIU. That is correct.

Representative HINSHAW. Has any final conclusion come from the study of that idea?

Dr. SIU. The conclusion now is that that finding is pretty firm, and that is a definite application. The question now is firstly, when do we get the toxicity clearance from Pure Food and Drug Administration, and secondly, when do we have the source powerful enough so that we can send bags of potatoes through? Those are the main questions confronting that particular problem.

Representative HINSHAW. Are they the ones that take this small dose from 10,000 to 50,000 reps?

Dr. SIU. Yes, sir. Some observations have also been made on onions and the inhibition of sprouting of onions. However, the results are erratic. In Spanish onions there seems to be an indication that radiation does inhibit the sprouting. But not so in pearl onions. In fact, in certain doses it even accelerated the sprouting of pearl onions.

Representative VAN ZANDT. Will you please discuss sugar and sirups? I notice you have them listed in another chart.

Dr. SIU. The reason for trying sirup is that there is often fungal growth in it. The idea is to sterilize it. The treatment does generate some off-flavor. So at the present moment the flavor change is so bad, that we would not consider sirup as a good commodity for radiation sterilization.

Representative VAN ZANDT. When these foods are irradiated, are they bug resistant?

Dr. SIU. No, sir. The bugs will like them just as much as unirradiated. That is why we must keep them in a package that will keep out the bugs.

Representative VAN ZANDT. Would the change of climate, for example, from the northern to tropical countries affect the food if it is irradiated?

Dr. SIU. Not any more than it will affect the unirradiated.

Representative HINSHAW. There seems to be an effect on sugar. Does that break down the sugar molecule in some way or add to it, or what?

Dr. SIU. Whether it attacks a particular sugar molecule or not is difficult to say. There are many chemical reactions that it does affect. For instance, some workers feel that it oxidizes one of the atoms on the sugar molecule into an acid grouping. But that is partially conjecture at the moment, and partially actual findings.

Representative HINSHAW. There are a good many different kinds of sugar, and in all possibility it does affect the sugar molecule itself.

Dr. SIU. That is correct, sir. I was referring just to glucose sugar. There may also be some hydrolysis of the sucrose sugar.

Representative VAN ZANDT. Doctor, what is the amount of radiation that the human body can consume?

Dr. SIU. Can consume in food?

Representative VAN ZANDT. How much radiation can it take when it is consumed in food?

Dr. SIU. There is no residual radiation in the food itself. This food has no radiation. The radiation just goes through. It is like a person taking an X-ray. After he leaves the X-ray machine, he doesn't have any X-rays in him. They just went through him. Those that have not penetrated the particular tissue but have bumped into a particular molecule, dissipate their energy in changing that particular molecule into another molecule in killing the bacteria, generating off-flavor or causing inoccuous transformations. There is no residual radiation in the food.

Representative HINSHAW. I think the lethal dose for a human is 500 roentgens.

Dr. SIU. About 400–500 roentgens is the lethal amount. That is if the rays are directly hitting on him.

Representative HINSHAW. And this is 10,000 and 50,000.

Dr. SIU. That is correct, sir.

Representative HINSHAW. That is considerably more than is lethal to a human being.

Dr. SIU. That is why you kill the bacteria. In other words, you are directing the rays against the bacteria in the food. The food does not retain any of the radiation.

With this short sketch, I think you can see that the number of problems as brought up by your questions and by my inability to answer them are very, very many. But there are many enticing rewards. When the chips are finally down, the question always comes up, what is the cost. At the present time there is no firm cost figure. There are many guesses. We are conducting an economic feasibility study to refine the current guesses on the cost of irradiation. The guesses run today between a fraction of a cent to about 7 cents per

pound. But considering the added advantage, these guesses are still within the competitive range of the conventional methods of food processing.

Representative PRICE. What does it cost to freeze and handle a pound of frozen fruits compared to your one-half to 7 cents for radiation sterilization?

Dr. SIU. I would prefer to ask Colonel Jackson if he knows the precise cost of freezing.

Colonel JACKSON. I do not know the precise cost of frozen food. We will have to put that in the record, sir.

Representative PRICE. Very well.

(The information referred to follows:)

APPROXIMATE COSTS

1. Cost of freezing is 0.2 to 0.4 cents per pound.
2. Cost of producing frozen foods (exclusive of package and components) is 2 to 3.5 cents per pound.
3. Cost of producing canned foods is 0.25 to 2.5 cents per pound.
4. Comparative shipping costs:
   (*a*) San Francisco to Japan.
   Refrigerated, 6.4 cents per pound.
   Nonrefrigerated, 1.9 cents per pound.
   (*b*) Chicago to San Francisco.
   Refrigerated, 2.1 cents per pound.
   Nonrefrigerated, 1.5 cents per pound.
5. Comparative storage costs (exclusive of handling to and out of plant):
   Refrigerated, 0.13 to 0.26 cents per pound per month.
   Nonrefrigerated, 0.03 cents per pound per month.

Representative PRICE. Dr. Siu, I wonder if you would give us some examples of what you have experimented with, and what you have accomplished.

Dr. SIU. May I ask your permission to pass that question on to General Hastings. I think he has a lot of actual live samples to show you in his presentation.

Representative PRICE. In other words, we will come to that point where you will show us in tangible form what you have done.

Dr. SIU. Yes, sir. We will try to congeal some of my words.

Representative HINSHAW. If you will pardon me, Mr. Chairman, I think that this offers another interesting point, and that is that if all of these various foods were either sterilized or kept from sprouting or something of that sort, for the same population that we have in the United States, it would decrease the amount of agricultural land necessary to grow them on by the amount you save. In other words, you could feed an additional population on that which is wasted by spoilage and by sprouting and so forth now.

Has any estimate been made of that amount of land?

Dr. SIU. We have not, sir; but we will try to make an estimate.

(The information referred to follows:)

Figures obtained from the Department of Agriculture for 1954 are:
Acreage under potatoes in United States, 1,404,000.
Total crop, 355 million bushels.
Loss (fed to livestock, shrinkage after harvest, etc.) 29 million bushels.
The loss figure could not be broken down further into loss caused by sprouting and others.

Representative VAN ZANDT. Doctor, will you explain the cost factor again? If I recall correctly, you said 1 to 7 cents a pound?

Dr. SIU. A fraction of a cent to 7 cents per pound is the current guess. There have been several studies made. For instance, the

University of Michigan made a study on the estimate of the cost of inhibiting the sprouting of potatoes. They estimate several mills per pound or 2 mills per pound if they get the gamma fuel assemblies free. These estimates are based on several contingencies of that sort.

There were other rough economic estimates, including the cost of the reactor, and the cost of labor and everything. These come up to about 2 to 6 cents a pound for a sterilizing dose.

Representative PRICE. Doctor, Mr. Hinshaw brought up a very interesting question. It is quite natural that this will have an impact on the future plannings of agriculture and the productivity of the soil and so forth. If you had an irradiation program in effect for potatoes, we probably would not have gotten into the situation a few years back when we had a great surplus of potatoes which we had to let spoil. If this program is successful, we would be in a position to ship those potatoes into areas where they would be required.

Dr. SIU. That is correct, sir. It will give you certainly more months of leeway in which you have to make a decision and take action.

Representative VAN ZANDT. Doctor, would these irradiated potatoes withstand the effects of salt air and moisture? I am thinking of potatoes stored aboard a ship exposed to the elements of the sea. If the potatoes were irradiated, would they be able to withstand the effect of the salt moisture?

Dr. SIU. Yes, sir. They would be not much different from the fresh potatoes in the unsprouted stage. I think with the hardened skin it will withstand quite a bit of moisture.

Representative VAN ZANDT. What can you see in the future in the way of rations for a military man? Today he has a small kit that contains canned foods, packaged chocolates, so-called dog biscuits, and so forth. What can you foresee for the military man in the future if this program is successful?

Dr. SIU. I can conjecture from past experience. When we had no refrigeration ships in the beginning days of an emergency, we had to feed our troops for months and months and months on canned meats. Irradiated fresh foods will not require refrigeration ships and our troops can have their fresh meats and fruits during the early days of the war as well as during the days when you have stabilized warfare. As far as the type of rations are concerned, it is difficult to say exactly what will be supplied on the very frontlines. That depends upon your battle tactics and whether you demand utmost mobility. If you demand utmost mobility, that means you might not even have time to cook the meal. In that case you would have no alternative but to use your canned rations. But even here we should expect that the canned foods themselves will have a far more delicious taste, if sterilized by radiation instead of destructive heat processing.

Representative VAN ZANDT. I can see then the necessity for the elimination of thousands upon thousands of mobile refrigerators that have to be dragged ashore to refrigerate the food for troops at military installations.

Dr. SIU. Yes, sir; I think I might summarize the discussion on the current state of the art by saying it is very optimistic.

Representative PRICE. Thank you very much, Dr. Siu, for a very interesting presentation.

General Hertford, will you present the last witness?

General HERTFORD. The last is Major General Hastings, the Quartermaster General, who will summarize the program and pass out some exhibits that we have.

Representative PRICE. We are glad to hear you.

STATEMENT OF MAJ. GEN. K. L. HASTINGS, THE QUARTERMASTER GENERAL

General HASTINGS. Thank you, Mr. Chairman.

Mr. Chairman and members of the committee, and ladies and gentlemen: May I summarize the prospects for the future of this research and development program. From the preceding presentations, it appears evident that we stand on the threshold of a broad new method of food preservation.

Although radiation sterilization is not yet a commercial reality the possibilities for the future are most encouraging. Today we know that:

1. The need for a successfully irradiated food product does exist within the Department of Defense.
2. Irradiation can eradicate all living contamination occurring in food with no more than a few degrees rise in temperature in the food.
3. This process allows irradiated food to be stored, unrefrigerated, for extended periods of time without danger of spoilage.
4. All evidence to date indicates that irradiated food is wholesome.
5. Different foods react differently when treated by radiation.
6. Cost factors are reasonable.

In order to bring radiation source technology into proper perspective with the food technology aspects of this program, our plan considers the design and construction of a pilot plant facility having a capacity of approximately 1,000 tons per month in 1958. Based on an operating experience factor of 2 years, for such a pilot plant, a commercial unit can be designed. It is hoped that by this time sufficient interest will have been generated within the food industry to permit commercial exploitation without Government subsidy.

To provide you with a concrete picture of what we have discussed here today, the Army has prepared a small brochure which it is my privilege to distribute to the committee members. Within the booklet we have indicated our aims, accomplishments, types of radiation sources, and have included small samples of food that have been subjected to this radically new process.

In closing this presentation, we have several samples of various items of food which have been treated which we would like to submit for your perusal.

Here is the potato.

Representative PRICE. These were irradiated in July 1954?

General HASTINGS. Yes, sir.

Representative PRICE. Would they be edible?

Colonel JACKSON. The laboratory specimen does not say so, but we believe so, sir.

These are some of the meat items. These were just irradiated last week. They are sterile. You can notice the color has not changed.

(Demonstration of various products, including irradiated bread, frankfurters, pork loin, sirloin beef roast, baloney, liverwurst, cottage cheese, carrots, spinach, and corn.) (Exhibit 14, p. 57.)

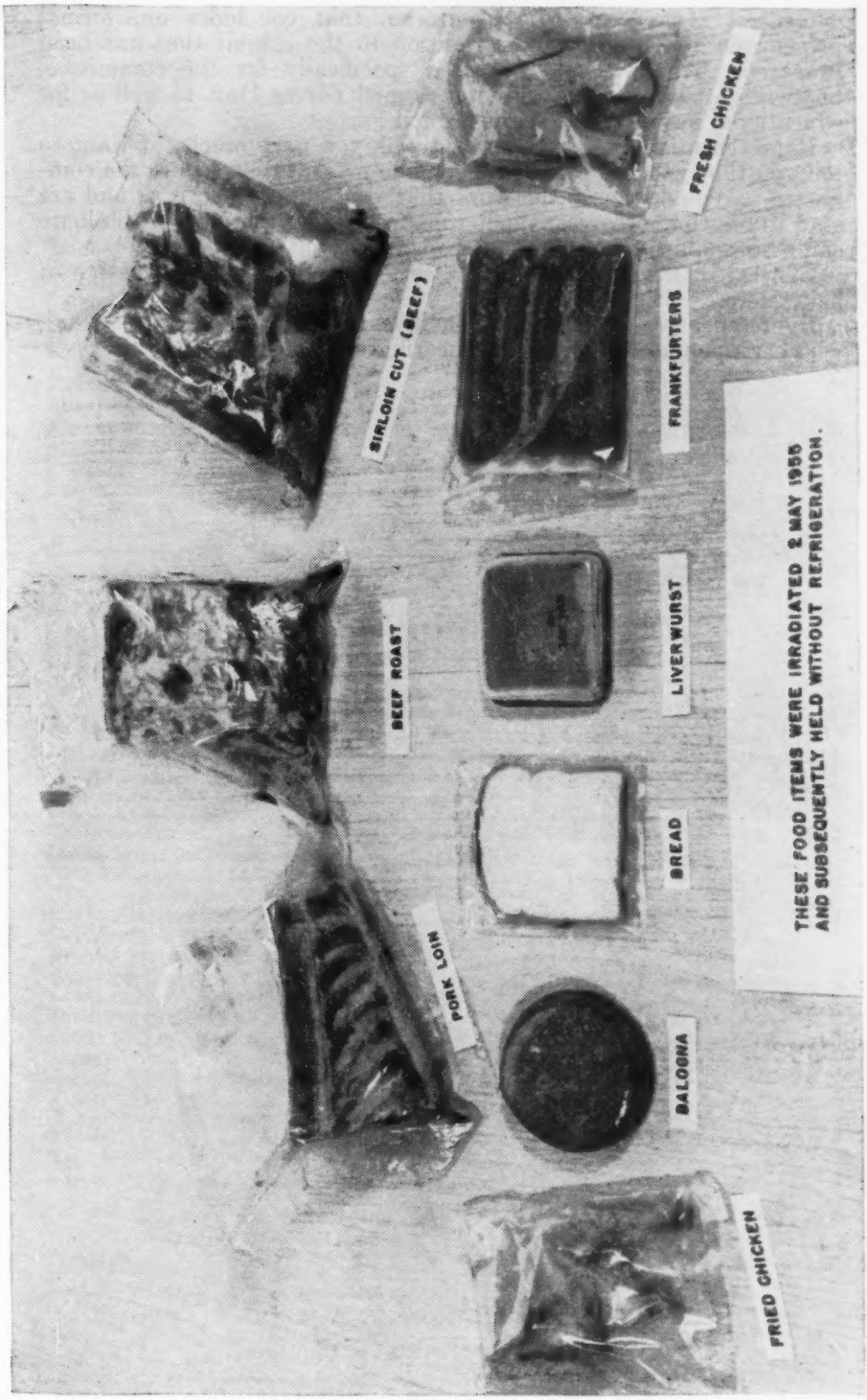

FRESH CHICKEN
SIRLOIN CUT (BEEF)
FRANKFURTERS
BEEF ROAST
LIVERWURST
PORK LOIN
BREAD
BALOGNA
FRIED CHICKEN
THESE FOOD ITEMS WERE IRRADIATED 2 MAY 1955
AND SUBSEQUENTLY HELD WITHOUT REFRIGERATION.

EXHIBIT 14

General HERTFORD. Mr. Chairman, that concludes our formal presentation. I invite your attention to the exhibit that has been prepared. This was not prepared specifically for the committee, but will be part of our exhibit for Armed Forces Day, as well as for educational use throughout the Armed Forces.

Representative PRICE. General, thank you very much. I want to tell you that you have made a very fine presentation before the committee. We appreciate the work that you have put into it, and are glad to see that progress is being made in this program. I think we can assure you that our committee is deeply interested in it.

General HERTFORD. Thank you, sir. We are very appreciative of being here.

Representative PRICE. That concludes the hearing.

(Thereupon at 3:20 p. m., the hearing was concluded.)

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